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Report No. 33.

SIXTEENTH ANNUAL REPORT

OF THE

RESEARCH COUNCIL OF ALBERTA

1935

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The Research Council of Alberta, formerly known as The Scientific and Industrial Research Council of Alberta, was formed in January, 1921. It was incorporated under its new name by an act of the Legislature of the Province of Alberta, March 21st, 1930.

In the organization of the Provincial Government the Research Council was attached to the Department of the Executive Council. The Research Council, until March 31st, 1933, controlled the policies of research and administered the funds voted by the Legislature.

No separate vote of funds for the Council has been made by the Legislature since 1932, but arrangements were made by which the University of Alberta took over the senior members of the staff and provided for the continuation of some sections of the work. A skeleton organization has thus been preserved which may be readily expanded when funds are again available.

The Director of Research, Dr. R. C. Wallace, President of the University of Alberta, is in executive charge of the work and is assisted by a technical advisory committee consisting of the following members:

President R. C. Wallace, Chairman.
Dean R. S. L. Wilson, Vice-Chairman.
J. A. Allan
E. H. Boomer
K. A. Clark
H. J. MacLeod
N. C. Pitcher
R. L. Rutherford
J. W. Shipley
E. Stansfield
F. A. Wyatt
A. E. Cameron, Secretary.

The permanent staff of the Research Council through the year was as follows:

E. Stansfield, Chief Chemical Engineer;
K. A. Clark, Research Engineer, Road Materials;
R. L. Rutherford, Geologist, Geology;
W. A. Lang, Engineer, Fuels;
K. C. Gilbart, Engineer, Fuels;
Hazel M. Wortman, Stenographer.

In addition to the above, members of the Faculty of the University of Alberta have been in permanent charge of sections of the Council's research work as follows: Dr. J. A. Allan, Geology; Professor N. C. Pitcher, Mining Engineering; Dr. F. A. Wyatt, Soil Survey; and Dr. E. H. Boomer, Natural Gas and Hydrogenation.

The offices and laboratories of the Council are situated in the buildings of the University of Alberta. Requests for information and reports should be addressed to the Secretary, Research Council of Alberta, University of Alberta, Edmonton, Canada.

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University of Alberta,
Edmonton, Canada,
February 19th, 1936.

Hon. William Aberhart,
Premier,
Edmonton, Alberta.

Sir:

I herewith submit the Sixteenth Annual Report of the Research Council of Alberta, covering work by members of the staff of the Council during the year ending December 31st, 1935, and references to the continuation by the University of Alberta of work controlled by the Research Council in earlier years.

Respectfully submitted,

Robert C. Wallace,
Director of Research.

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Sixteenth Annual Report of the Research Council of Alberta

No separate vote of funds for the Council has been made by the Legislature since 1932, and no meetings of the Council have been held; but the University of Alberta has provided for a continuation of a small portion of the work. The amount of work undertaken during 1935 was approximately the same as in 1933 and 1934.

The researches on natural gas were rendered possible by financial assistance from the National Research Council and from the Carnegie Corporation Research Fund administered by the University. The latter fund also assisted the work of the Road Materials Division.

Publication of the annual reports of Council had been suspended for two years, but the reports for 1932, 1933 and 1934 were this year published in one volume. The continuity of reports for 15 years has thus been maintained.

Brief summaries of the work of the Fuels, Geological Survey, Road Materials, Soil Survey and Natural Gas Divisions are given below: more detailed accounts of four of these are attached as an appendix to this report.

FUELS

The work of this Division included special investigations for certain coal operators and for several government departments. These latter included The Department of Lands and Mines—Mines Branch and Petroleum and Natural Gas Division; The Attorney General's Department; and The Department of Trade and Industry.

The construction and use of coal charts was further developed during the year and more of these were made available for operators. Progress was made with the study of the oxidizability of Alberta coals and the correlation of this work with danger of spontaneous combustion in the gob and in stock pile.

The house heating equipment was dismantled in 1934 to give additional room in the Mining Laboratories, since then house heating tests have only been possible when they could be carried out in private residences. One test was completed in the 1934-35 winter and another test was begun in November. Tests on the ignition temperature of coal were made as a guide for the safe design of coal driers in two coal washeries. The above investigations are in addition to the regular analytical work of the Division.

Comparative tests of soft wood, and birch, charcoals were made and of the use of such charcoals in heaters. An extensive investigation of petroleum products was carried out in preparation for the public sessions in Calgary of the Dominion of Canada Tariff Board—Reference No. 84, Crude Petroleum and Derivatives. Assistance was also given to the Sir Montague Barlow Royal Commission on the Coal Industry of Alberta.

GEOLOGY

The work of the Geological Division of the Council is directed by J. A. Allan in conjunction with the Department of Geology at the University of Alberta.

Funds were not made available to maintain a field party throughout the season. Work was carried on by J. A. Allan throughout the year; and about two months were spent in the field. The small appropriation for field work was utilized on a survey of the greater part of the Sounding Creek Topographical Sheet, extending from Hand hills and Hanna east to the Alberta-Saskatchewan boundary and between townships 25 and 32 inclusive, representing approximately 4,500 square miles. Most of the time was spent in the Sheerness coal area on a study of a continuation eastward of the coal seams in the Drumheller basin. The water resources in the area of the Sounding Creek sheet was also considered and possible horizons determined. There is still some geological work to be done along the southern boundary of this sheet. Examinations were made on the building stone and tufa deposits in the Cochrane district and on tufa deposits between Cochrane and the Calgary Power Company dam at Ghost river. Details of the field work carried out by the Geological Survey Division are given in a later part of this report.

Available information was supplied, as far as possible, by J. A. Allan and R. L. Rutherford to the numerous requests received. Much valuable assistance was received from Mr. William Calder, Director of the Petroleum and Natural Gas Division of the Department of Lands and Mines, and also from his successor, Mr. Charles W. Dingman.

ROAD MATERIALS

The study of highway subgrades commenced in 1934 was continued. One month was spent in the field and many samples of soil and gravel were collected for laboratory examination. A soil profile was made on the highway running north from Edmonton through Morinville. The gravel deposit at Hinton and soil conditions between Hinton and the boundary of Jasper Park were studied to determine the possibilities for constructing a stabilized, gravel surface highway. A deliquescent salt, such as calcium chloride, would be added in such highway surfacing.

A detailed traffic count on Highway No. 1, south of Edmonton, was carried out for six days in July.

SOIL SURVEYS

No funds were available for field surveys during the year. The only activity to be reported for this Division is the publication of the soil survey report for the Peace River-High Prairie-Sturgeon Lake Area. This report was prepared by Dr. F. A. Wyatt, in co-operation with Dr. J. L. Doughty, Dr. A. Leahey and Mr. A. D. Paul. It includes one sketch map, ten photographs, and a large soil map in colours. The report was compiled from five adjacent surveys conducted between the years 1928 and 1931. It includes all of two and parts of the other three surveys. The area included in the report is about 108 miles square with McLennan as the approximate geographical center.

NATURAL GAS

Three separate lines of research were in progress during the year. The first relates to the solubilities of gaseous hydrocarbons, such as occur in natural gas, in the liquid hydrocarbons with which they are associated in Turner Valley. The object of the investigation is to ascertain the actual conditions which must exist underground in the Turner Valley Field. Such information is of great importance for guidance in the conservation of the resources of this field.

The second concerns the oxidation of natural gas in order to produce methyl alcohol, formic acid, formaldehyde and possibly other liquid products of commercial value. In short, to convert gas now being wasted into an economic asset.

The third investigation, on the polymerization of natural gas, is similar to the second in its economic significance. It is found possible, by polymerization, to convert natural gas into a liquid fuel which can be added to the natural naphthas and gasolines and thereby increase their anti-knock character.

PUBLICATIONS BY MEMBERS OF THE STAFF

Report No. 28. Thirteenth Annual Report of the Research Council of Alberta.

Report No. 29. Fourteenth Annual Report of the Research Council of Alberta.

Report No. 32. Fifteenth Annual Report of the Research Council of Alberta.

Report No. 31. Preliminary Soil Survey of the Peace River-High Prairie-Sturgeon Lake Area, by F. A. Wyatt.

Some examples of Frost Boils Occurring on Alberta Highways, by K. A. Clark. The Canadian Engineer, Sept. 10, 1935, p. 7.

Hydrogenation in a Tetralin Medium. Canadian Journal of Research, B 13, December, 1935.

I.—Destructive Hydrogenation of Bitumen and Pitch, by E. H. Boomer and J. Edwards, p. 323.

II.—Destructive Hydrogenation of Coal with Tetralin and with a Mixture of Related Compounds as Media, by E. H. Boomer and J. Edwards, p. 331.

III.—Destructive Hydrogenation of Cellulose and Wood, by E. H. Boomer, G. H. Argue, and J. Edwards, p. 337.

IV.—Destructive Hydrogenation of Grain Screenings, by E. H. Boomer and J. Edwards, p. 343.

FUELS DIVISION

By E. Stansfield, W. A. Lang and K. C. Gilbart

The staff of the Division consisted of the three members listed above. As before, W. A. Lang assisted in the teaching work of the Chemistry Department of the University, and E. Stansfield assisted in the teaching work of the Mining Engineering Department.

The Industrial Laboratories of the University supplied for one month the services of an extra assistant, required during a period of emergency.

No notable change was made in either laboratory accommodation or equipment during the year.

SAMPLES RECEIVED

Provincial Mine Inspectors submitted 38 ordinary channel samples from operating coal mines and 27 other samples for special tests; they also submitted 2 dust samples from a coal mine. Operators submitted 6 samples for special investigation. Other coal samples included 18 from the University Power Plant, 2 geologist's field samples, 2 from house heating tests and 1 coal briquette. Miscellaneous samples included 3 charcoals, 4 woods for making into charcoal, 9 crude oils, 4 naphthas, 34 gasolines, 17 distillates and kerosines, and 5 Deisel oils.

Samples were received during the year from 12 mines not previously sampled. Samples have been analysed to date from 368 mines located in 145 townships. This gives a good idea of the wide distribution of the mines.

SAMPLING AND ANALYSIS

No change in regular methods was made during the year. A new drying oven was constructed, with glycerine and water instead of toluene to maintain the desired constant temperature of 107°C, but this involved no change in procedure.

The special methods employed in this laboratory for "air drying" and for the determination of true or capacity moisture of coal, have been continued and found satisfactory. A notation is now made on the analysis report when the total moisture found differs from the capacity moisture by more than 0.25% on coals with not more than 5% capacity moisture; by more than 0.45% on coals with over 5% and not more than 20% capacity moisture; and by more than 0.75% on coals with over 20% capacity moisture. A study of the analyses of 104 regular channel samples, on which capacity moistures have been determined, showed that with 58% of the samples the capacity moisture and the standard moisture agreed within the above limits, 40% of the samples contained enough surface moisture to bring them outside the limits, and only 2% were outside the limits on the dry side. One sample showed 5.2% of surface moisture, 22 showed between 1 and 2%, and the average value for all the samples was over 0.5%. Only one sample showed a deficiency of over 1% of moisture.

A comparison of the regular and capacity moisture figures for a number of mines shows that the latter gives a notably more consistent value for the true moisture of the coal in each mine, and on the average, gives a value 0.5% lower than does the regular value which may include surface moisture. It is clear that in the past the coals of the Province have been lowered in grading by thus including the surface water in the analysis.

Coal Charts and Their Use

It has been found that with Alberta coals the heat value, proximate analysis and ultimate analysis, vary in a regular manner with the ash and moisture percentages. It is therefore possible to prepare a set of charts, for any coal, from which can be read the heat value and analysis corresponding to any particular ash and moisture.

The construction and use of such coal charts has been further developed in these laboratories during the year. A description of the four most common charts is given below.

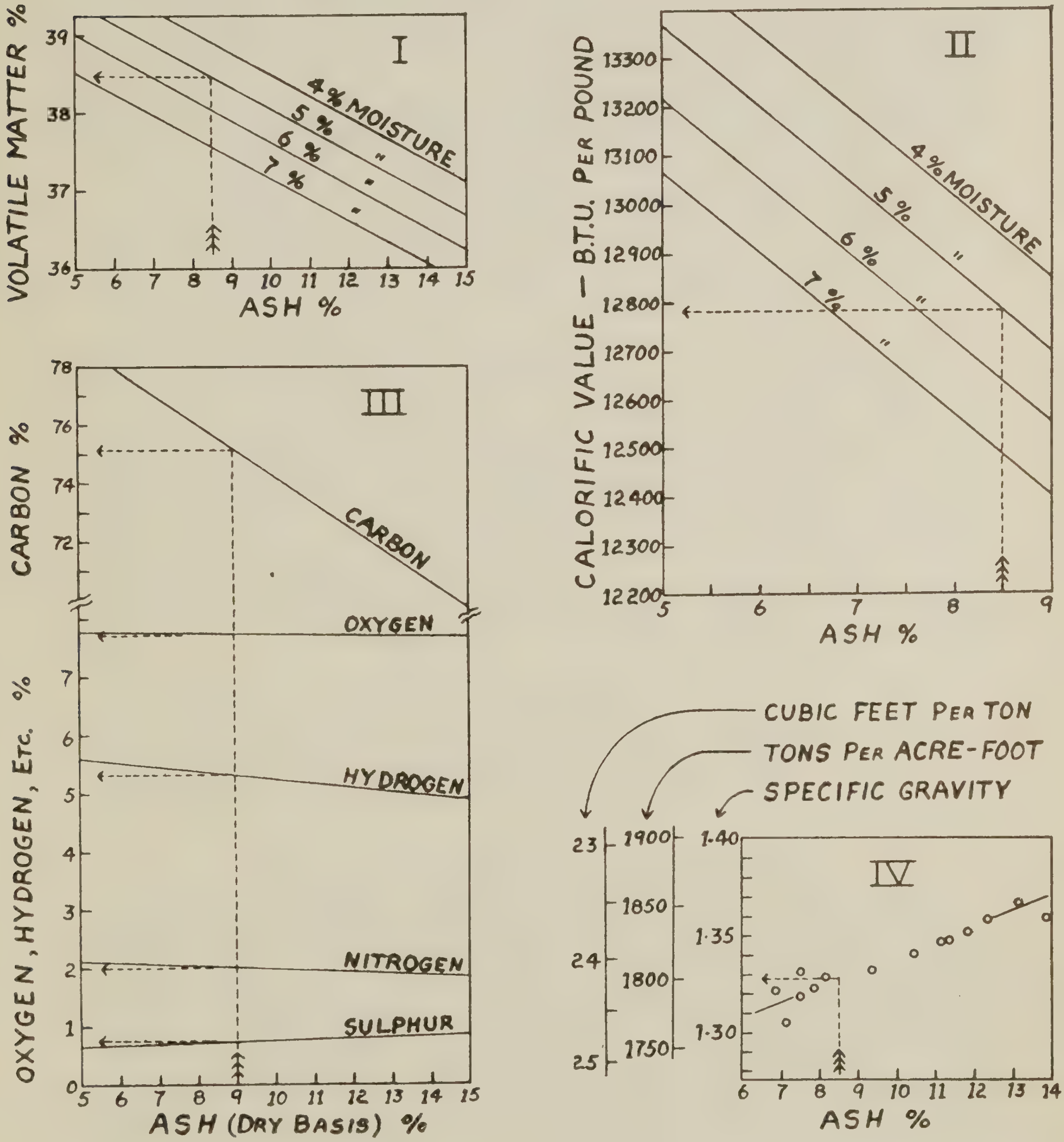

Fig. 1.—Examples of four coal charts.

Since the samples received and analysed in these laboratories are seam samples they may not represent the commercial output of the mine. Every operator can control, within limits, the cleanliness of his output, and the limits are notably widened at the mines where coal cleaning plants are in operation. It is therefore appropriate that the operator should decide for himself the probable ash and moisture percentage of the coal he proposes to supply. He can then ascertain, by the use of these charts, the complete proximate, ultimate and calorific analysis of the coal.

The chart for ultimate analysis, Chart III in Fig. I, only shows the ultimate analysis of the dry coal, but charts can be prepared for computing the analysis of any moist coal from the corresponding analysis of the dry coal.

Examples of four types of charts are shown in Fig. I, and explanations of their use are given below. The coal X selected for example is a sub-bituminous coal. The actual charts prepared are larger than the examples shown, they are drawn on squared paper for ease in use, they cover a wider ash range, and the scales are varied to suit the particular coal.

It should be particularly noted that the analyses represented in the charts are of fresh coal, and not of coal weathered in pillar or stock pile.

The use of these charts permits an operator when he has decided upon the probable ash and moisture percentages of the coal he tenders,—giving due consideration to the size of the coal, degree of preparation, dryness of the mine, etc.—to them give a close approximation to the probable analysis.

Chart I.—Proximate Analysis of Coal X

This chart has scales for volatile matter, ash and moisture. The volatile matter corresponding to 8.5% ash and 5.0% moisture, for example, is found by starting at the 8.5% ash point on the bottom scale, moving vertically upwards as indicated by the dotted line to intersection with the inclined 5.0% moisture line, and then moving horizontally to the left to meet the volatile matter scale. This shows that the corresponding volatile matter is 38.4%. The fixed carbon is then calculated by adding together the three percentages of ash, moisture and volatile matter and subtracting the sum from 100. The full proximate analysis is therefore: ash 8.5, moisture 5.0, volatile matter 38.4, fixed carbon 48.1—total 100%. Analyses corresponding to other ash and moisture percentages can be similarly found.

Chart II.—Calorific Value of Coal X

This chart is similar to Chart I, except that the vertical scale shows B.t.u. per pound. In an exactly similar manner it can be found that the coal with 8.5% of ash and 5.0% of moisture will have a heat value of approximately 12,780 B.t.u. per pound.

Chart III.—Ultimate Analysis of Coal X

This chart shows two vertical scales, to cover the constituents carbon, oxygen, hydrogen, nitrogen and sulphur; in some cases three or more scales are required. The chart only shows the analysis of the dry coal, as it would require to be too complicated to show variations with moisture. The users of ultimate analyses are generally prepared to convert these to any particular moisture content as required. It can be seen that by following the dotted line up from the 9% ash point, that this cuts the sulphur line opposite 0.8% on the left hand scale, cuts the nitrogen line at 2.0%, the hydrogen line at 5.3%, the oxygen at 7.8% and the carbon at 75.1%. The full analysis on the dry basis is therefore: carbon 75.1, hydrogen 5.3, ash 9.0, sulphur 0.8, nitrogen 2.0, and oxygen 7.8—total

100%. Note that 9.0% ash was taken in this example since 8.5% ash with 5.0% moisture corresponds to nearly 9% ash on the dry basis.

Chart IV.—Volume-weight of Coal X

The density of Alberta coals varies somewhat with the kind of coal, but varies more with the ash percentage. Separate lumps of the same coal may vary in density due to the presence of different mineral impurities, although they may give the same ash percentage when burned. It is therefore not justifiable to show a single line chart to relate ash with density; at best a band could be indicated. In the chart the circles mark the determined values for a number of lumps of Coal X. The chart indicates that this coal, with 8.5% ash will normally have a specific gravity of about 1.33, will weigh about 1,800 tons per acre-foot, and occupy about 24.2 cubic feet per ton. The figures refer to tons of 2,000 lbs. and to the solid coal as it occurs in the seam.

Charts have been prepared for a number of individual mines as analyses have been made and the necessary data obtained. In other cases where sufficient data for the single mines is not available it may be possible to provide charts applicable to groups of similar mines. It is planned to continue the compilation of data for such charts as the necessary samples are received.

ALBERTA COAL SURVEY

No work specific to the three Alberta Coal Surveys previously described was carried out during the year, but some of the regular work of the laboratory was closely related to these surveys.

CLASSIFICATION OF COAL

Studies relating to classification were continued during the year, particularly with respect to the relation between the moisture and ash percentages of any coal. Detailed studies were made of the relation of moisture and ash in every band of coal, bone, clay and shale, from one mine in the Milk River Area and from another mine in the Edmonton Area. It has not yet been found possible to complete this work for publication. The object of the investigation, as stated last year, is to determine if possible a method for computing the analysis of pure coal, for classification purposes, which will not show an unduly high moisture content.

The studies, referred to last year, of the relation between volatile and fixed heat in Alberta coals gave some interesting results. The attempt to use this ratio for coal classification has not been successful; but the ratio may have distinct value in a consideration of the steam raising quality of the coal.

DETERMINATION OF THE OXIDIZABILITY OF COAL

During the year 18 runs were made, with the apparatus described in last year's report, on 14 different coals. Each run takes more than a week to complete. General test runs were made with this apparatus to prove that the dedusting treatment planned by one company did not render the coal more susceptible to spontaneous combustion. Tests were also made to correlate the low temperature oxidation of coal with the heat given out. Work is in progress to reduce or eliminate the uncertainty with respect to coals that give off methane which masks the absorption of oxygen. Progress has also been made in the correlation of these tests with spontaneous combustion in the gob and stock pile.

HOUSE HEATING TESTS

The house heating equipment at the University had to be dismantled in 1934 to provide the additional laboratory accommodation required by the Department of Mining Engineering. It is therefore only possible to continue this work when it can be done in a private residence. The tests of a Francis Automatic Air Balance Control commenced in December, 1934, were completed in January, 1935; and later in the year another investigation was commenced as described below.

Francis Automatic Air Balance Control: The operation and efficiency of this device was tested in a five-room, frame bungalow, 26′×38′, in Edmonton. The device is essentially a thermostatically controlled flue pipe check damper; a thermostat opens and closes a butterfly damper in a side opening with change in temperature of the flue gases. When the fire gets hot the thermostat gradually opens the check damper and checks the fire, as the fire cools off the damper gradually closes. A more uniform condition can thus be maintained than is normally the case with hand control. The house was hot air heated with a McClary No. 416 coal furnace with a 16″ grate. Additional heat during the tests came from the gas fired water heater in basement and the gas range in the kitchen, but this was not recorded.

The control device was installed in place of a length of flue pipe; the regular check damper was left in position. The controlled and the regular check dampers were used alternately in two sets of tests; the one not in use being sealed off.

The consumption of coal, production of ashes, and evaporation of water for humidification were recorded daily, and recording instruments registered inside, outside and flue temperatures; inside humidity; flue draft and carbon dioxide in the flue gases. The general running of the furnace and maintenance of house conditions were kept as nearly normal as possible during the tests.

A preliminary run on one coal from the Pembina Area was made with the Francis device from December 17 to 20th, inclusive. The other tests were made on a different coal from the same coal area. December 27th to 29th and January 8th to 13th inclusive the Francis device was used, whilst December 30th to January 7th the standard check damper was used. The tests were subdivided into periods of similar temperature conditions; the outside temperature during the tests ranged from 30°F above to 30° below zero.

It should be particularly noted that a number of factors cannot be controlled in house heating tests, especially when these are carried out in an occupied residence. The principal disturbing factor is the wind, which varies in intensity and in direction; less heat is also required on a bright sunny day than on a dull day. Living conditions are also a disturbing factor, with irregularities due to washing, cooking, visitors to the house, etc. It is also impossible to ensure that there is the same amount of fuel in the furnace at the beginning and end of each day, or even at the start and stop of the test. More prolonged tests would be necessary to equalise the disturbing factors.

Full details of all the tests, with charts, were compiled and submitted to the firm for which the tests were made.

In brief it was concluded that the Francis Air Balance Control furnace attachment is a distinct aid to the furnace operator in the maintenance of steady conditions. The thermostatic operation of the check damper reduces the need for personal attention; it automatically checks the fire when hot and removes the check as the fire cools down; and it reduces the risk of an overheated furnace and flue pipe. It should be noted, however, that it cannot obviate the need for adjustments to meet the needs of wide variations in outside temperature.

The results gave some indication of increased efficiency with the device, but this increase cannot be certified as due to the device, owing to the uncertainty of short scale tests.

Certain results of general interest can be mentioned. The average amount of furnace heat required to heat the residence increased fairly steadily with increase of difference of temperature between the inside and outside of the house. This is shown in Table I.

TABLE I.—HOUSE HEATING REQUIREMENT

Average Difference in Temperature °F	Furnace Heat Required	
	Therms	Pounds of coal, as fired
50	60	63
60	75	78
70	89	93
80	103	108
90	118	123
100	132	138

The unit of heat employed, the "therm," is 10,000 B.t.u.

Residence Heating with Gas.

House heating tests were started in November on the residence of a member of the staff. This work is being done with the co-operation of the Northwestern Utilities Ltd. The plan of the investigation is to keep accurate records through a winter of the heating of a house under normal residence conditions and to relate the data to prevailing weather conditions.

The heating plant is a No. 521 McClary Radium warm air furnace with a No. 18 Good Cheer Conversion Gas burner. The gas feed is controlled by a Minneapolis Honeywell Manual Thermostat. As installed this controlled the whole flow of gas to the burner. It was modified to maintain a low heat in the furnace at all times through a hand operated by-pass and only thermostatically control part of the flow. A more steady temperature is thus achieved.

Records are being kept of the following: Outside temperature, humidity, wind velocity and direction, and barometer; house temperatures at 9 points, humidity, flue temperature, gas and electricity consumption, and amount of water evaporated for humidification. The observations are made at four times during the day.

IGNITION TEMPERATURE OF COAL

The ignition temperatures of two subbituminous coals were tested during the year to give guidance in the design of the drying equipment for two wet washeries.

It was found that these coals gave ignition temperatures of about 174°C (345°F) by the Wheeler method and 375°C (705°F) by the Research Council of Alberta (R.C.A.) method.

The two tests are quite different and have different significance. In the Wheeler method as employed the coal is ground to just pass a 200 mesh screen, completely oven dried, and slowly heated in a current of oxygen. The temperature recorded, 174°C, is that at which the coal commences to oxidise, and therefore heat, with notable rapidity.

In the R.C.A. method the coal, with its inherent moisture as received, is crushed to just pass a 4 mesh screen and screened over an 8 mesh screen. Small portions of this sample are spread out in single layer thickness on a wire mesh through which a brisk current of hot air is rising. The lowest temperature of

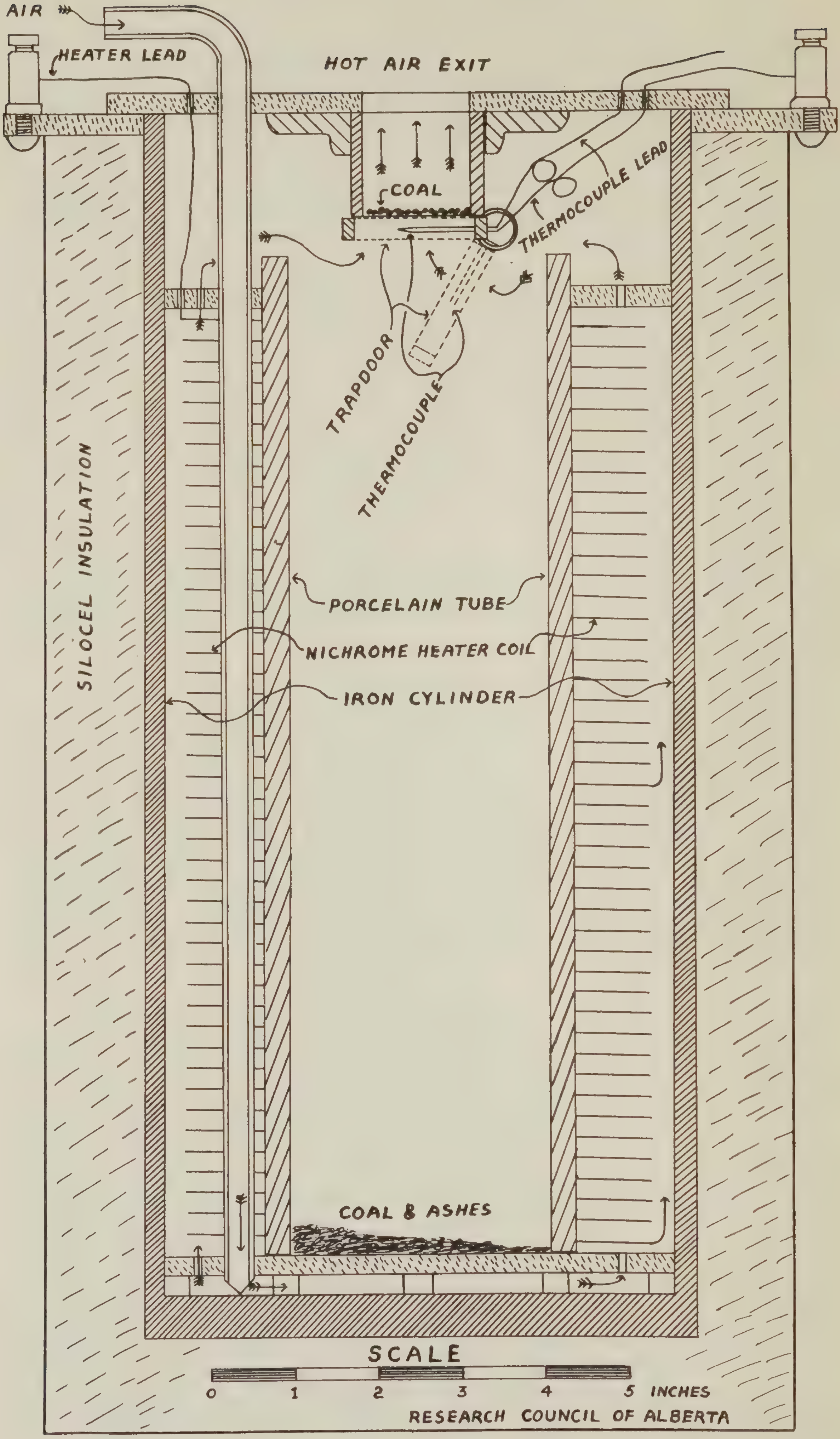

Fig. 2.—Apparatus for ignition temperature of coal.

air which will actually ignite one or more pieces of the coal within three minutes is taken as the ignition temperature.

The Wheeler method is capable of greater exactness of determination, and the determined temperature can be taken as the danger limit for the coal; but it is suggested that the term "ignition temperature" is more correctly applied to the results of the R.C.A. method. The latter temperature may be taken as the temperature at which fire would almost inevitably follow even short exposure in a coal drier as soon as the surface moisture was removed.

The R.C.A. apparatus is sketched in Fig. 2. The apparatus consists in the main of a nichrome wire heater built around a porcelain tube, the whole being placed within a cylindrical iron vessels, 6″ in diameter and 14″ deep, well insulated outside. The heating coil contains 60 feet of No. 18 gauge nichrome with connections to the ends and middle. There are thus two 30-foot coils which can be heated in series or parallel. The current is controlled with a rheostat. An air current, not carefully measured but of about 1 cubic foot per minute, is blown in through the ¼″ iron pipe and taken to the bottom of the iron vessel. It rises through small holes in a distributing plate and is heated by the nichrome wire. This heated air is used to ignite the coal.

At the top of the apparatus is a short length of 1¼″ bore iron pipe, attached to the under side of the transit board cover. The bottom of the pipe is closed by a nichrome frame covered by fine, stainless steel wire gauze. The frame, which is hinged, thus forms a hollow, gauze covered, trap door through which the hot air can rise. Inside the trap door is a thermocouple, consisting of No. 26 gauge iron-constantin wires, for measuring the temperature of the air.

When a test is to be made the raw coal is crushed to just pass a 4 mesh screen and the fines passing 8 mesh are removed. The electric current and air blast are turned on and the air temperature gradually raised. From time to time a portion of the sample (18-25 pieces) sufficient to about cover the trap door one layer deep, is dropped onto the trap door and watched for about 3 minutes. The air temperature is gradually raised until one or more pieces catch fire within that period. The experiment is repeated, with more careful air temperature control, to get the lowest temperature for ignition. At the end of each observation period, or sooner if the coal catches fire, the trap door is dropped and the test charge falls to the bottom of the apparatus. This obviates irregularity of temperature due to combustion of the coal. The trap door is weighted, but held closed during the test by a fine wire.

It is noted that near the critical temperature rarely more than one or two pieces catch fire before the trap door is dropped. There must therefore be a notable difference in ignition temperature of the separate particles of the same sample. The lowest temperature is the significant temperature to record, as fire at any point would quickly spread through the rest of the coal.

BRIQUETTING OF COAL

A few tests were carried out for one operator to ascertain the absolute minimum of binder that could be employed to make a briquette that did not fall to pieces.

CHARCOAL TESTS

Comparative tests were made on samples of poplar and birch charcoals, and on their use in railway car heaters. Comparative tests were also made on charcoals made in the laboratory from four different varieties of wood. Tests were also made on the evolution of carbon monoxide in a charcoal stove.

Comparison of Poplar and Birch Charcoals.

Analyses of two samples submitted is shown in Table II.

TABLE II.—ANALYSES OF CHARCOAL

		Poplar Charcoal		Birch Charcoal	
		As Received	Oven Dried	As Received	Oven Dried
Moisture	%	11.4	......	3.7	......
Ash	%	5.9	6.6	2.3	2.3
Volatile Matter	%	9.3	10.5	21.1	21.9
Fixed Carbon	%	73.4	82.9	72.9	75.8
Heat Value	B.t.u. /lb.	11,710	13,210	13,000	13,500

The poplar charcoal was wetter than the birch charcoal, but it was better burned and so contained less volatile matter. It was probably made from dead fall wood which would account for the higher ash. If it had been as clean as the birch charcoal its heat value might have been the higher. It can be seen, therefore, that there need not be any marked difference in analysis between the two varieties. There is, however, a very marked difference in physical character. The poplar charcoal had been made from unsound wood, and was notably inferior in general appearance; it was also much more bulky. A half bushel measure, equally filled, with equally sized pieces of the charcoal as received and analysed was found to hold about 5 lbs. of poplar charcoal and 8½ lbs. of birch charcoal. The size and weight of several small pieces were measured and it was found that it took 7 inch cubes of poplar charcoal to weigh an ounce, but only 4 inch cubes of birch charcoal. It was thus shown that in the bulk, and in separate pieces, the poplar charcoal is notably lighter than the birch.

Charcoal in Railway Car Heaters.

Difficulty was experienced with maintaining a fire in one of these heaters for two or three days without attention; a difficulty mainly due to the absence of the frequent and violent shaking a railway car heater receives in actual use. The bulky nature of the poplar charcoal notably increased the difficulty and it would be necessary to use more finely crushed material. A heater which took a charge of 13 lbs. of birch charcoal only held 9 lbs. of the poplar charcoal submitted.

Comparison of Birch, Tamarack, Jack Pine and Poplar for Charcoal.

Two air dry logs of each variety of wood, each about 6″ diameter and free from bark, were used for the tests. Charcoal was made in a heavy, cast iron retort, externally heated. The retort was gradually heated till the charge reached the temperature of 350°C (662°F) and held at that temperature till the vapours were off—10 hours for the jack pine, 8 hours for the other woods.

The woods, as received, contained the following percentages of moisture:—birch 14.2%, tamarack 11.4%, jack pine 14.2% and poplar 11.4%. For comparison the following values have been computed to a common moisture basis of 15%.

The yields of charcoal, calculated as from 15% moisture wood, were: birch 27.6%, tamarack 30.4%, jack pine 29.8% and poplar 27.6%.

Analyses and densities of the woods and charcoals are given in Table III.

TABLE III.—ANALYSES OF WOOD AND CHARCOAL

	Birch		Tamarack		Jack Pine		Poplar	
	Wood	Charcoal	Wood	Charcoal	Wood	Charcoal	Wood	Charcoal
Moisture %	15.0	1.2	15.0	1.8	15.0	1.0	15.0	0.8
Ash %	0.3	0.9	0.2	0.6	0.2	0.5	0.6	1.2
Volatile Matter %	74.3	22.5	74.4	22.4	74.6	26.3	74.4	24.1
Fixed Carbon %	10.4	75.4	10.4	75.2	10.2	72.3	10.0	73.9
Calorific value, B.t.u. /lb.	7,170	13,810	7,470	13,870	7,620	13,740	7,110	13,840
Density: Inch cubes to 1 oz.	2.6	4.6	3.6	6.7	3.5	7.0	4.1	7.3

It was found that good charcoals could be made from all the woods tested and that neither the yields nor the analyses differed greatly. The birch and birch charcoal are notably denser than the soft woods and their charcoal, and the soft wood charcoal is also slightly more friable. The soft wood charcoals are therefore inferior to birch charcoal in physical properties although equal to it in chemical properties.

Evolution of Carbon Monoxide from a Charcoal Burning Heater.

The stove, without chimney, was installed in an unventilated room 17×10×13 feet high. Three 7-hour tests were made with poplar charcoal at rates of combustion ranging from 13¾ down to 10¼ lbs. per 24 hours.

It was found that the heater generated carbon monoxide in dangerous amounts and that the danger increased as the heater was damped down.

Samples of gases taken from a vent to the heater were found to contain up to 0.5% carbon monoxide, and samples of air from the room contained up to 0.05%. Prolonged breathing of air with 0.05% of this poisonous gas would certainly be very dangerous. It had been suggested that the poplar charcoal submitted was safe as it contained no carbon monoxide. No variety of charcoal would normally contain any monoxide, but any charcoal can, and generally does produce this deadly poisonous gas when burned in any slow combustion heater.

All the above work on charcoal was carried out at the request of the Trade Commissioner of Alberta, and reported to him.

PETROLEUM INVESTIGATION FOR TARIFF BOARD ENQUIRY

This investigation was carried out for the Attorney General's Department of the Province of Alberta. The work took the full time of the staff for almost two months and the services of a student assistant for one month. The results were reported in full to the Attorney General's Department, but, in addition, E. Stansfield gave evidence at the public sitting of the Dominion of Canada Tariff Board—Reference No. 84, Crude Petroleum and Derivatives—at Calgary on May 29th.

The samples tested totalled 69. Ten of the samples were received from the Petroleum Division of the Department of Lands and Mines, and the remainder from the Attorney General's Department. Thirteen of the samples were taken from the United States, two from British Columbia and the rest from Alberta. The samples covered a wide range of fuels, crude oils, naphthas, gasolines, kerosenes, distillates and Diesel oils.

Thorough chemical analyses and physical tests were made on all the samples. It was not, however, possible to determine the "octane rating" for the gasoline samples as the test engine required was not available. It should be noted in this connection that two brands of gasoline, of different price levels, may only differ in their octane rating.

A few of the points of general interest brought out in this investigation are outlined below.

The Measurement of Gasoline, Kerosene, etc., for Sale.

Gasoline, kerosene, etc., are sold in Canada on the basis of the Imperial gallon measured at 60°F.

In the wholesale trade the actual measuring is by weight, and this avoids any error due to temperature variation.

In the retail trade the oil is measured by volume, and errors are involved when the oil is measured at some temperature other than 60°F.

The purchaser gains when the temperature of the oil as measured is below 60°F, and loses when the temperature is higher.

The respective percentage gains (+) and losses (—) to the purchaser, of petroleum products of varying gravity (°A.P.I.) are shown for temperatures ranging from 0—100°F in Table IV.

TABLE IV.—PERCENTAGE GAIN OR LOSS TO PURCHASER WITH TEMPERATURE

Gravity °A.P.I.	Lbs. Weight Gallon at 60°F	Gain (+) or Loss (—) to Purchaser at Temperature of: 0°F	20°F	40°F	60°F	80°F	100°F
30	8.76	+2.6	+1.7	+0.9	0	—0.9	—1.7
40	8.25	+2.8	+1.9	+1.0	0	—1.0	—1.9
50	7.80	+3.2	+2.2	+1.1	0	—1.1	—2.2
60	7.39	+3.7	+2.5	+1.2	0	—1.2	—2.5
70	7.02	+4.1	+2.8	+1.4	0	—1.4	....
80	6.69	+4.5	+3.0	+1.5	0	—1.5	....
90	6.39	+5.0	+3.3	+1.7	0	—1.7	....

It might be noted that the density or gravity of petroleum is stated in degrees of the American Petroleum Institute (°A.P.I.). The higher the degrees, the lighter the material. Gasoline with high degrees A.P.I. is called high test gasoline.

Distillation Results.

Probably the most significant test for the evaluation of an automotive fuel is the distillation test. The sample is heated in a standard distilling flask fitted with a thermometer, and connected to a condenser and collecting measure. The temperature of the vapours are noted from time to time and the corresponding volume of distillate collected. The temperature when the first drop of distillate is collected is called the initial boiling point (I.B.P.); the temperatures are also noted when 10%, 20% . . . 90% of distillate are collected. The maximum temperature at the end is also noted as the end point (E.P.). If the liquid is very volatile some is inevitably lost, so that the total percentage recovered is also significant.

The curve shown in Fig. 3 gives typical distillation curves for Alberta naphtha, gasoline, distillate and kerosene. The figures on the left show the temperatures in Fahrenheit degrees, whilst the figures along the bottom show the percentage recoveries. These curves indicate clearly the differences between the four types of liquid fuels, but the four types merge into each other in commercial samples.

Sulphur.

Sulphur occurs in several forms in petroleums, and in any form is objectionable. The total sulphur is reported in analyses. Tests are also made to ascertain if the sample will corrode or stain copper or will show sulphur by the "doctor test." Sulphur is of especial interest in Alberta as crude naphthas

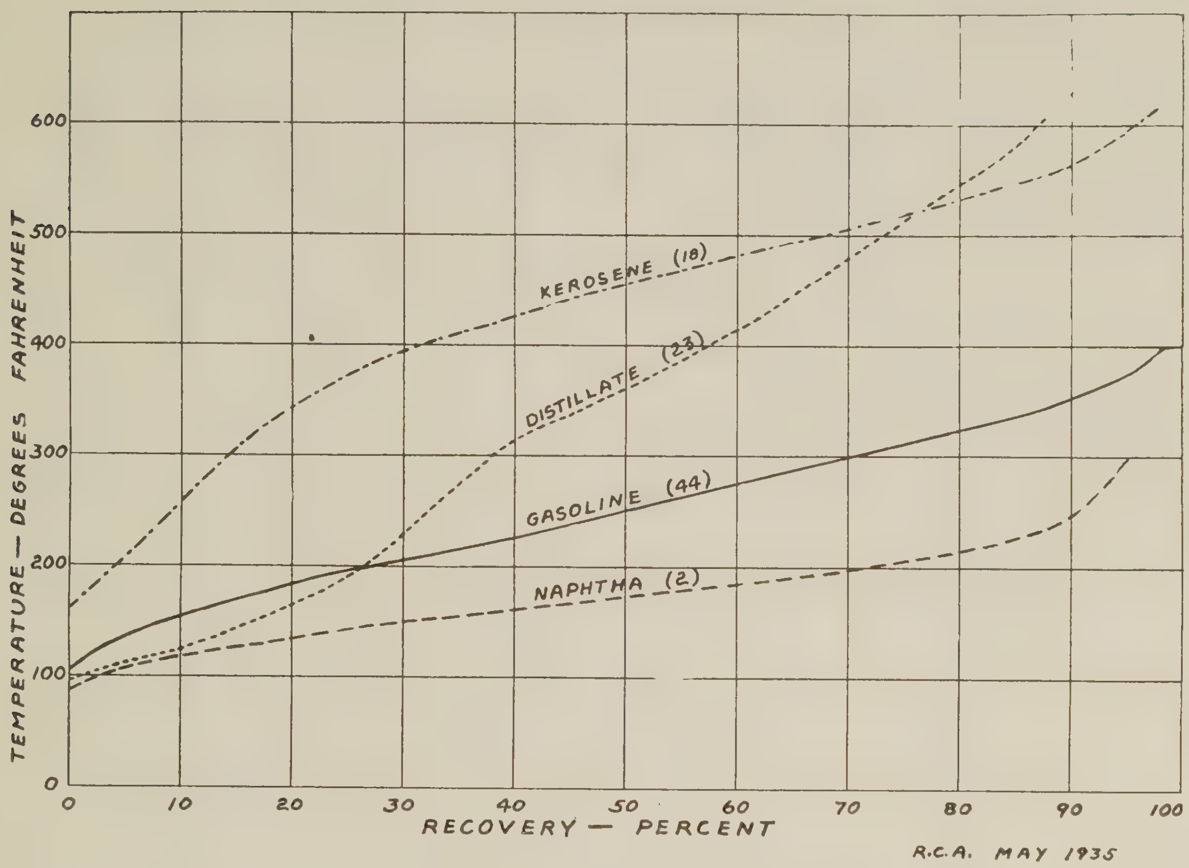

Fig. 3.—Typical distillation charts.

are sometimes sold which contain notable percentages of sulphur, corrode copper and show "sour" by the doctor test.

A crude oil was found with 2.4% sulphur, a Diesel oil with 1.5%, a distillate with 0.6%, and a naphtha with 0.3% showing bad copper corrosion and sour doctor test. These, however, were extreme cases; practically all commercial gasolines showed no copper corrosion and were sweet, with a sulphur content rarely as high as 0.2%.

Any sulphur burns in the engine to sulphur dioxide. This by itself is probably harmless, but if it comes into the presence of condensed water anywhere in the system it dissolves to form sulphurous acid, and this oxidises to form sulphuric acid. Both these acids are extremely corrosive. Since this corrosion requires condensed water, it can be seen that the danger is materially increased in cold weather and with intermittent running of the engine. It should be noted that complete removal of sulphur is expensive, causes loss of a considerable percentage of the fuel, and causes a reduction of the octane rating. Its removal, however, notably decreases risk of engine damage.

Reid Vapour Pressure.

Any petroleum in a closed container will generate a vapour pressure. Some petroleum products will generate a high pressure, and such products are both dangerous to handle and store and also result in large losses by evaporation. They would, however, give quick starting of an engine in cold weather. The Reid test is the standard method for evaluating this factor, and the test is carried out by measuring the pressure generated under standard conditions at 100°F. One crude naphtha, received in a bomb, showed a pressure of nearly 19 pounds. One commercial gasoline showed 17 lbs., but most commercial gasolines have pressures under 10 lbs. Kerosenes, etc., would have very low pressures, and these were not measured.

It was thought desirable to ascertain how the Reid vapour pressure would vary with the temperature. A large number of determinations were made at several temperatures, and the curves shown in Fig. 4 were based on these results. It will be noticed that the pressures increase rapidly with increase in temperature. In winter months a gasoline can be safely employed which might prove dangerous in summer.

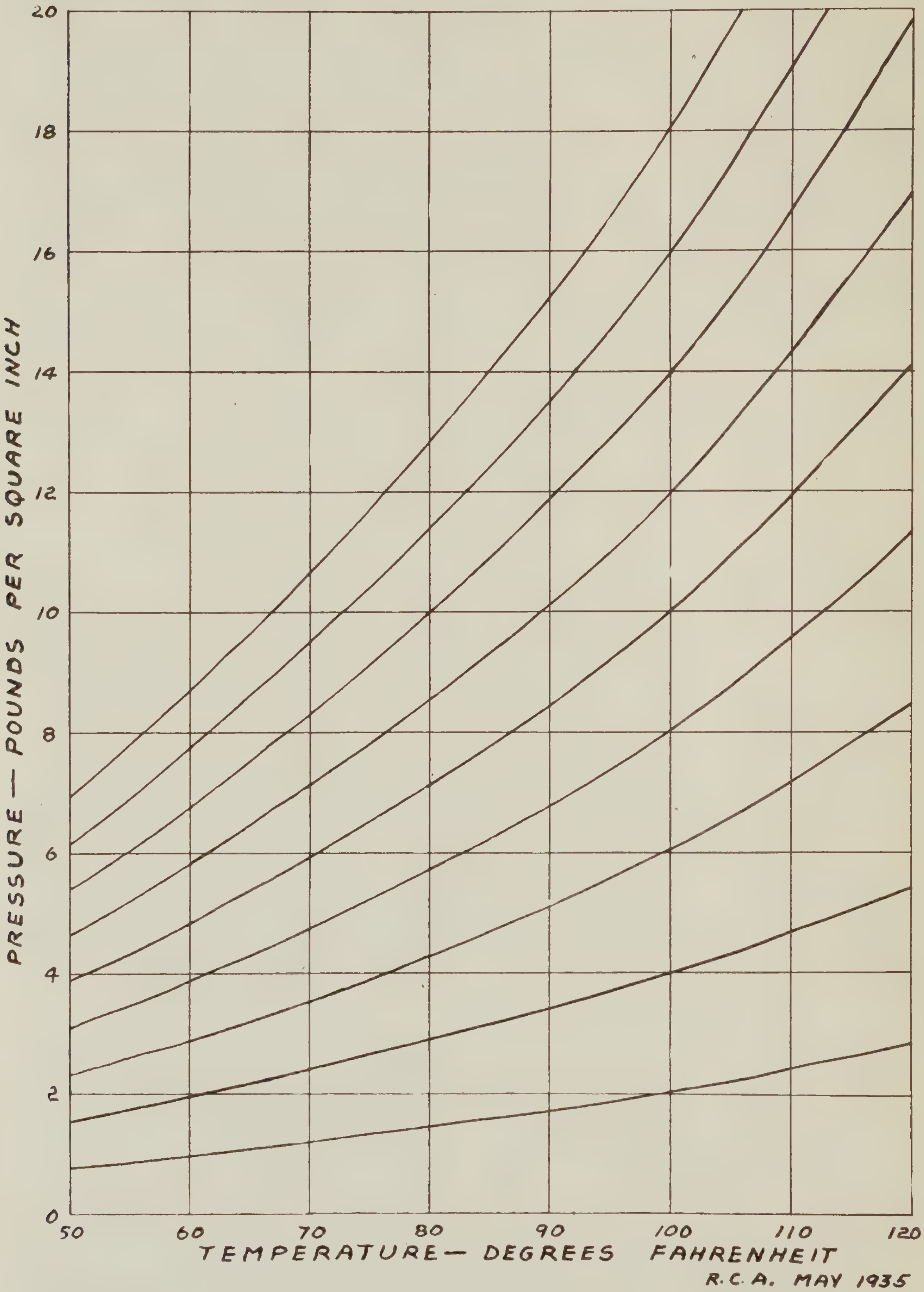

Fig. 4.—Reid vapour pressure—temperature relations.

Calorific Value.

The calorific value of a fuel is its basic evaluation, but this determination is seldom made. It is, however, possible to closely estimate its value from its density.

The two following curves were prepared from tables published by the United States Bureau of Standards.[1] Fig. 5 shows the actual calorific value per gallon or per pound in thousands of B.t.u. The lower curves, net heat at constant pressure, are the more significant value for comparison of different fuels. Fig. 6 shows the relative heat values of petroleums of different gravity, when the heat value of a gasoline of 60° A.P.I. is taken at 100. It may be noted as an apparent anomaly, that the higher the test of the gasoline or other product, and the higher the probable price per gallon, the lower the heat value per gallon. This might be restated by saying that it is most profitable to purchase a low test gasoline, or even a kerosene, distillate or Diesel oil *if* the engine employed will burn such fuel efficiently. The automobile engine frequently does not burn low test gasoline efficiently, and ease of starting is lost, hence it is often advisable to burn high test material.

MISCELLANEOUS

Data was collected for, and information was supplied to, the Sir Montague Barlow Royal Commission on the Coal Industry.

Assistance was given to local firms with respect to the tempering of duraluminum and to gas furnace patents.

This Department is also co-operating with the Mines Branch in the collection and tabulation of figures showing the weight per cubic foot of stored coal, of different sizes, from the principal mining districts in the Province. This work is not yet completed.

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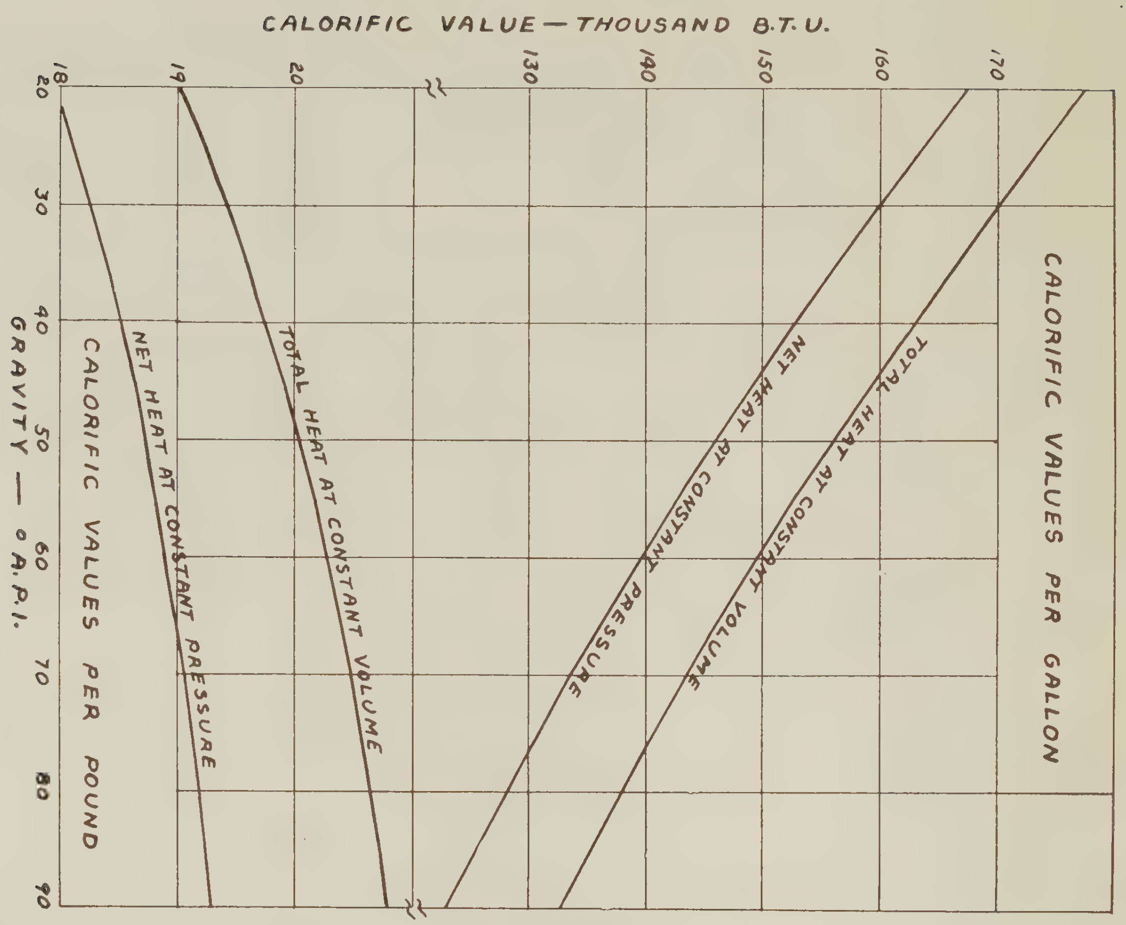
[1] Thermal Properties of Petroleum Products: Miscellaneous Publication of the Bureau of Standards, No. 97.



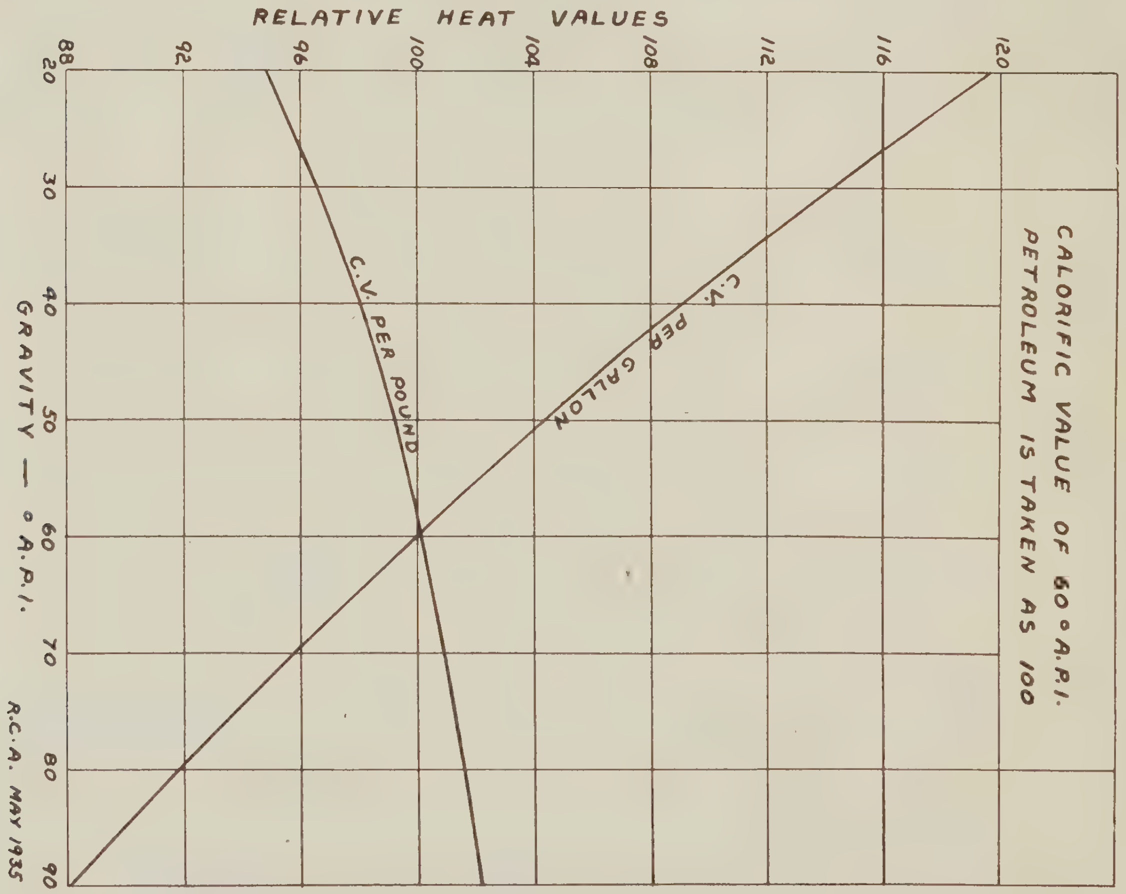


Fig. 5.—Calorific values of petroleum products.

Fig. 6.—Relative calorific values.

GEOLOGICAL SURVEY DIVISION

BY J. A. ALLAN

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ILLUSTRATIONS

Plate 1. Map showing distribution of geological formations.
Eight photographs illustrating geological features.

INTRODUCTION

Appropriations made for field surveys were not sufficient to maintain a field party throughout the season. During July and August field work was carried on under the direction of the writer, assisted by Donald A. Taylor with G. A. Allen as helper. During August H. A. McCorquodale was engaged as assistant instrument man in order to carry out a levelling survey in the Sheerness district.

Most of the field work was carried out in the Hanna and Sheerness districts and a preliminary report of this operation is given below. The writer takes this opportunity to extend thanks to the officials of the various mines and to many friends in Hanna and throughout the districts who so kindly extended assistance. Particularly is thanks extended to Manager G. Bennett, Leavell Coal Co.; Mr. C. Gallinger and Manager R. L. Wood, Chinook Coal Co.; A. J. Bordula; Morse Bros.; and B. A. Kirkeby at their respective coal mines; and Mr. Rowden, well-driller. Special thanks is extended to Mr. H. C. McConkey of Drumheller for his assistance in supplying data and in various other ways.

At the beginning of the field season a few days were spent examining the Oliver sandstone quarry and tufa deposits at Cochrane, and also a tufa deposit on the Bow river opposite Radnor. A few notes on these observations are given below.

GEOLOGY OF SOUNDING CREEK SHEET AND SHEERNESS COAL AREA

Approximately six weeks were spent by the writer, assisted by D. A. Taylor, investigating the geology from the Hand hills east to the Alberta-Saskatchewan boundary and between townships 25 and 32 inclusive. Most of this area is included in the Sounding Creek sectional sheet No. 166, published by the Topographical Survey of Canada. The area examined represents about 5,000 square miles. Most of the time was spent in the western part of this rectangular area and especially in the Sheerness and Hanna districts within the Sheerness Coal Area as defined by the writer in Report No. 10, Research Council of Alberta, 1924, and officially accepted by the Alberta Mines Branch and the Dominion Mines Branch.

The object of this survey was twofold; namely, to study the geology of the Sheerness coal basin, which has been developed in the past five years as an important domestic coal field, and, secondly, to investigate the underground water supply, and the possible source of underground water in a part of Alberta where there is not an adequate water supply.

Before it is possible to interpret data relative to the extent of a coal basin or the water resources of any area it is necessary to study the geology of the area, the succession of the rock formations, the characteristics and structure of the various strata, and to obtain as much data as possible from the wells that have been dug or drilled.

In 1921 the geology of the Drumheller coal basin was studied by the writer and the results were published by the Research Council of Alberta as Report No. 4. In 1924 a geological survey was extended from the Drumheller coal basin easterly to Hand hills and included the area represented by the Rosebud and Red Deer sectional sheets, approximately 9,000 square miles. The maps and sections on this area, compiled by J. O. G. Sanderson and the writer, indicate the correlation of the coal seams in the Edmonton formation and their extension as far east as Hand hills. It was considered advisable to extend the study on the coal seams as far east as the Edmonton formation occurred and more particularly in the Sheerness district south of Hanna where there has been developed by strip mining as well as by small underground mines an important coal basin.

In this report only preliminary data will be included as the detailed results will be compiled into a more complete report at a later date.

From the field investigations conducted by the Geological Survey Division of the Research Council of Alberta, to the west of Hand hills and along the Red Deer river, it was found that the Edmonton formation is at least 1,224 feet in thickness and that this formation contains at least fourteen coal seams, of which eight of these seams have been mined at different places. These seams from the bottom of the formation upwards were designated by the writers by numbers one to fourteen respectively. In the Drumheller basin coal seams, Nos. 1 and 5 are mined almost exclusively. In the Carbon coal area most of the production is from Seam No. 11.

The strata in the Edmonton formation rise to the east and it is the lower part of the series that occurs at the surface east of Hand hills. At least the horizons represented by the lowest six coal seams in the formation were observed between Sheerness and the Hand hills. The coal seams are thinner in the Sheerness basin than in the Drumheller basin.

Surface Features

The surface of the Sounding Creek sheet between the seventh and ninth base lines and from the Hand hills to the east boundary of the province is characterized by low relief. The highest part occurs at the western border of this sheet on the eastern slope of the Hand hills and particularly east of Hand hills lake eight miles southwest of Hanna where the greatest elevation is approximately 3,200 feet above sea-level. Handhills lake is in a depression almost one hundred feet below the surrounding country. The water in this lake is strongly alkaline, and the lake is drying up very rapidly as the shore line has receded about 600 feet and the lake level has been lowered over 15 feet within the last ten years.

The Hand hills are one of the prominent physical features in Alberta east of the foothills. These hills are residual hills resulting from erosion and are therefore similar in origin to Cypress hills, Wintering hills, Swan hills, Cariboo mountains, Birch hills and other erosion residual in Alberta east of the foothills. The surface of Hand hills is irregularly rounded and the highest part is in range 17 where the elevation is about 3,550 feet above sea-level, or approximately 900 feet higher than Hanna.

From the Hand hills the surface slopes rapidly to the north, to the east and to the south and to the west. Dowling lake, which has become obliterated by evaporation, at the northwest corner of the map area and six miles north of Hanna, has an elevation of 2,595 feet above sea-level. Along the eastern side of the Alberta boundary from Alsask north to Loverna and about 90 miles east of Handhills lake the surface elevation ranges from 2,250 to 2,300 feet above sea-level. The lowest part of this map area is about 2,150 feet above sea-level in the southwest corner on the Red Deer river at Finnegan ferry.

There are several areas of extremely rolling land beyond the Hand hills causd by glacial moraine. Only a brief mention will be made of some of these in this report. North and west of Hanna occurs the Dowling lake morainal districts, consisting of sand hills which extend westward across range 16 and into range 17. Another sand hill area of moraine extends north and east of Scotfield and Youngstown. It is a fact that east of Range 7 much of the surface is moraine covered but much thicker morainal deposits occur in some places than in others. These thick moraines are characterized by sand hills, circular depressions and in general quite an irregular surface. The presence of widespread glacial deposits is the cause of the scarcity of rock outcrops.

There are other areas particularly along the immediate drainage of Bullpound, Berry, Blood Indian, Alkali and Sounding creeks where there is only a thin veneer of glacial debris, and in many places moraine is absent.

A soil survey and a soil map of the Sounding Creek sheet was made by Dr. F. A. Wyatt and Dr. J. D. Newton in 1927 and their report has been published as Bulletin No. 16, College of Agriculture, University of Alberta.

General Geology

The map (Plate 1) accompanying this report shows the distribution of the geological formations in townships 25 to 32 inclusive and in ranges 1 to 18 west of the 4th meridian.

The succession of strata as represented at the surface in the Sounding creek map area and west to Range 17 includes the following:

Recent		Glacial gravels, sand and clays. Boulders occur but are not numerous.
Tertiary—	Oligocene?	Partly indurated gravels and sands capping Hand hills and about 150 feet thick.
	Paskapoo	Sandstones, mostly soft—yellowish with some shale and thin layers of carbonaceous shale. More than 250 feet thick.

Upper Cretaceous	Edmonton	Grey to yellow sandstone, grey to black shale with ironstone nodules, bentonite, coal shale and coal seams. Thickness varies but about 400 feet on the east slope of Hand hills. There is an erosional contact at the top of this formation.
	Bearpaw	Brown shales underlain by dark grey to black shales with ironstone nodular bands and several bentonite beds. The thickness of these marine shales is variable but an average of about 500 feet.
	Belly River	Sandstone and shale of brackish and freshwater origin, variegated in color. Thickness 800 to 1,000 feet minimum in drill holes but maximum thickness unknown.

Recent deposits: Alluvial deposits and residual soils are widespread chiefly along the drainage courses. Many depressions formerly containing water have been filled in with fine sediment. Several of the small lakes in this area have been filled or dried up within the last ten years. Glacial moraines are widespread. There are glacial boulders sparsely scattered over the upper slopes of Hand hills, and a few boulders were found on the highest points which indicate that the glaciers covered the Hand hills at one stage. The boulders are chiefly of igneous rocks that have been transported by the Keewatin glaciers from the Precambrian area to the northeast.

Tertiary-Oligocene: An area of between twelve and fifteen square miles on the top of Hand hills is underlain by a flat lying series of partly indurated gravels and sands, which form an escarpement of conglomerate about 150 feet in thickness. This formation is considered to be Oligocene in age and is similar to a formation capping the Cypress hills in southeastern Alberta and the Swan hills south of Lesser Slave lake.

Paskapoo formation: This formation occurs at the base of the Tertiary and is of Eocene age. It has been correlated with the Fort Union and Upper Paleocene in southeastern Alberta by L. S. Russell.

This formation underlies the upper part of Hand hills. Within this map area the Paskapoo occurs at the southwest corner of the map, on the west side of the Red Deer valley and at east end of Wintering hills. Another small area is shown at the northwest corner of the map. This series of beds is flat-lying and consists largely of soft yellowish sandstones. It is an important source of underground water of good quality.

The Paskapoo formation is separated from the underlying Edmonton formation by an erosional interval. West of this area and along the Red Deer valley J. O. G. Sanderson and the writer determined that by erosion at least 450 feet of the underlying beds have been removed before the Paskapoo beds were deposited under continental conditions.

Edmonton formation: One of the main objects of this survey was to determine and map the eastern boundary of the base of the Edmonton formation, and to obtain data on the position and character of the coal seams.

The eastern boundary of the Edmonton formation, based on all available data, is shown on the map accompanying this report (Plate 1). This eastern contact at the north boundary of the map in township 32 occurs about the centre of range 12. The contact extends in a southerly direction passing about one mile west of Richdale station and two miles east of Sheerness along the west side of the lower depression followed by Berry creek. In township 27 the contact swings to the west near Halliday station and then follows up the east side of Bullpound drainage to within three miles of Hanna. Here it crosses to the west side of Bullpound creek depression and continues south along the west side of this depression as far as the north of township 26, then the contact turns in a westerly direction along the Red Deer valley and passes from the Sounding creek sheet about the centre of township 26. The Edmonton-Bearpaw contact continues up the Red Deer valley to the mouth of Willow creek in township 28. On the west side of the Red Deer river the contact outcrops from river level opposite Willow creek down stream to township 25, where it extends to the south near Finnegan ferry and passes beyond the south boundary of the map. This part of the contact is shown on Map 9, the Rosebud sheet, which was published in 1925.

Bearpaw formation: The Bearpaw formation is largely of marine origin, and consists mainly of shales varying in color with grey, brown and green predominating. There are several bentonitic beds in this formation. One of the chief characteristics of bentonite is that it absorbs water rapidly up to seven times its own volume, and forms a very soapy-like clay. Small quantities of bentonite mixed with clay is commonly known as "gumbo." Where these shales with bentonite occur at the surface gumbo clays are produced which are very slippery when wet.

The Bearpaw shales occur close to the surface along the drainage of the Bullpound and Berry creeks and along the bottom of Red Deer valley, from Finnegan ferry, upstream past Dorothy to Willow creek. (Photograph 5.) The central part of this map area is underlain by this formation. The upper contact with the Edmonton occurs about a mile west of Richdale station in range 12 and the base of the Bearpaw in contact with the Belly River series occurs between Benton and Sibbald stations in range 2. The base of the Bearpaw cannot be determined accurately because outcrops are rare and there is a thick veneer of glacial moraine chiefly east of Chinook and range 7. There is no place on the Sounding Creek sheet where the thickness of the Bearpaw formation could be determined, but along the valley of Red Deer river the formation is about 500 feet. It is considered that the Bearpaw in this part of Alberta is 500 to 700 feet thick. At Oyen the Bearpaw is approximately 300 feet thick, as the water-bearing beds at the top of the Belly River were encountered as 295 and 300 feet in water wells.

The thickness of the Bearpaw is important from the point of water supply. Good domestic water is not found or is very seldom found in the Bearpaw strata. Water obtained from the Bearpaw is usually high in dissolved salts of which alkali is quite common. There are a few thin bands and lenses of limestone or sandstone which might contain usuable water, but these bands are indefinite in extent and cannot be depended upon as a source of water.

Belly River Series: The lowest formation in the Sounding Creek sheet belongs to the Belly River and consists largely of sandstones and shales of continental deposition. The contact between the Belly River and the overlying Bearpaw cannot be shown exactly, but in township 25 it occurs about range 7. In the centre of the map, the contact occurs west of Sibbald, about the west side of range 2, and in township 32 the contact occurs about range 5. There is also considerable glacial moraine over the surface of this formation. The sandstones in this formation are suitable as water-bearing strata, and it is known that potable waters are of widespread occurrence in the Belly River.

Sheerness Coal Basin

According to statistics supplied by the Alberta Mines Branch, there were sixteen mines in operation at the end of 1935. The first mine was opened in this area in 1910. In 1935 the output from all of the mines in the coal area amounted to 91,024 tons, of which 74,472 tons were derived from stripping or open-cut pits and the bulk of this amount came from two large stripping mines at Sheerness, namely, the Leavell and the Chinook.

The following is a list of the mines in the Sheerness coal area:

		LS. S. T. R. Mer.	Kind of Mine
Leavell Coal Company, Ltd.		5-19-29-12- 4	Stripping pits
Chinook Coal Company, Ltd.		1-12-29-13- 4	Stripping pit
A. J. Bordula	S.W. ¼	9-19-29-14- 4	Underground
Morse Brothers		1-19-29-14- 4	Underground
T. E. Stubbs		1- 6-29-14- 4	Strip
D. W. Harvey	N.W. ¼	2- 6-30-13- 4	Strip
J. Malcolm (closed 1935)	S.W. ¼	8- 6-30-13- 4	Strip
H. Sward		5-35-28-13- 4	Underground
J. R. Hemstock		3-29-32-13- 4	Strip
Fred Pahl	N.E. ¼	7-30-32-13- 4	Strip
R. J. Unsworth		16-25-33-14- 4	Underground
G. Webber (closed 1935)		6-34-33-14- 4	Strip
T. G. Ironside		12- 5-34-13- 4	Strip
G. Smith (closed 1935)		7- 1-34-14- 4	Strip
B. A. Kirkeby	S.W. ¼	3- 3-33-16- 4	Strip
A. Miller		6-21-30-17- 4	Strip
E. B. Foye		9-21-30-17- 4	Underground
A. W. Ross & Partners		3-28-30-17- 4	Underground

Coal seams occur in the Edmonton formation and the coal development is confined almost entirely to the immediate vicinity of Sheerness on a branch of the Canadian National railway. Extensive strip mining operations were being carried on in 1935 at Sheerness by the Leavell Coal Company, Ltd., in L.S. 5, sec, 19, tp. 29, rg. 12, W. 4th, and by the Chinook Coal Co., Ltd. in L.S. 1, sec. 12, tp. 29, rg. 13, W. 4th. At twelve other places open cuts had been made to the coal seams, but none were being operated when visited and all are wagon mines. There are small underground mines at eight places in the area examined, but all are distant from the railway, and only two were seen in operation, namely, the Bordula mine and the Morse mine, in L.S. 9 and 1 respectively, in sec. 19, tp. 29, rg. 14, W. 4th. These two mines are only operated when the demand for coal arises. Coal is mined for the local wagon trade or taken to Hanna by truck, a distance of eleven miles.

In order to determine the position of the coal in the Sheerness basin a levelling survey was extended from Sheerness station to the two large strip mines and also west to the Bordula and Morse mines, and south to the Stubbs strip pit in L.S. 1, sec. 6, tp. 29, rg. 14, W. 4th.

Details are not given in this report, but certain results on the character of this coal basin are mentioned. It is the same coal seam that is mined in these two districts in the Sheerness basin. The coal seam being mined is the lowest in the Edmonton formation and may be correlated with Seam 1 in the Drumheller basin. In Bordula mine the coal seam occurs at 2,663.2 feet above sea-level and at the Leavell strip mine the elevation of the coal seam is 2,701.7 feet above sea-level. This coal seam rises to the east at the average rate of 3.4 feet to the mile. Between the two large strip mines at Sheerness the coal seam rises to the south at the rate of 9.8 feet to the mile. South of Bordula mine the coal seam rises at the rate of 7.8 feet to the mile. The northern extension of this basin has not been determined as sufficient data are not available.

The Bordula mine, in L.S. 9, sec. 19, tp. 29, rg. 14, W. 4th, is worked from a slope from the side of a small coulee. The slope is 90 feet long on a 1:3 grade. The coal seam consists of 40 inches of clean coal with a sandstone floor separated by 2 to 4 inches of bentonitic clay. An analysis of the coal shows the moisture content at 25.8 and the ash at 5.6%. This coal is of good quality and is blocky when mined. The cover is 51 to 80 feet.

The Morse mine is in L.S. 1, sec. 19, tp. 29, rg. 14, W. 4th, adjacent to the Bordula mine and the character of the coal is similar in the two mines and the cover is about 80 feet. This coal is removed by a slope entry from a draw at the west. The seam is clean and the coal is blocky and of good quality. An analyses shows the moisture content to be 25.3% and the ash 7.1%.

In a coulee of "badlands" near the Morse mine the following succession of strata and associated coal seams is exposed in N.E. ¼, sec. 18, tp. 29, rg. 14, W. 4th:

10′ 0″+	brown shale
3′10″	coal (Seam 6)
12′ 8″	rock
1′11″	coal (Seam 5)
12′ 2″	rock
0′ 8″	coal (Seam 4)
40′ 3″	rock
1′ 7″	coal (Seam 3)
9′ 6″	rock
0′ 3″	coal (Seam 2)
9′ 8″	rock
3′10″	coal (Seam 1)
34′ 4″+	rock

About three miles west of Sheerness there is a small area of badland erosion in which the following section is exposed in sections 20 and 21, tp. 29, rg. 13, W. 4th:

15′ 0″	drift
6′ 8″	rock
0′10″	coal
36′ 3″	rock
1′ 3″	coal and shale
13′ 5″	rock
2′ 0″	coal
14′ 3″	rock
3′ 0″+	coal (Seam 1)
7′ 0″	rock

Base concealed.

At the strip mines close to Sheerness the upper part of the section has been removed by erosion so that No. 1 seam comes close to the surface and is worked by removal of the thin cover of over burden.

Two strip pits are being worked by the Leavell Coal Company Ltd. in L.S. 5, sec. 19, tp. 29, rg. 12 (Photographs 1 and 2). In the north or No. 2 pit the following section was examined:

56″	glacial drift
8″	soft brown shale
12″	soft weathered coal
14″	black shale
5″	brown shale
12″	soft coal and shale
5″	brown bentonite, rusty on surface
13″	top coal with bone bands
76″	hard blocky clean coal

Hard sandstone floor.

In the south or No. 1 pit the section is as follows:

40″	glacial drift
18″	soft weathered coal
2″	chocolate brown bentonite
14″	soft powdery coal
2″	buff colored bentonite
3″	dark brown bentonite
87″	coal, including topcoal
2″	brown sand

Hard sandstone floor.

The country about Sheerness is quite barren of natural trees, but a most attractive artificial oasis has been made at the clean, well arranged company site. Trees have been planted and flowers and vegetables grow profusely as a result of irrigation that is applied with the water from the coal mine.

A large strip pit is being worked by the Chinook Coal Company in L.S. 1, sec. 12, tp. 22, rg. 13, and the pit was being enlarged by removal of the upper 4 to 6 feet with grader elevator and dump wagons. When the coal seam has been cleaned off, the coal is broken out with bars and loaded by man power. (Photographs 3 and 4.)

The section exposed at the west working face is as follows:

40″	glacial drift
16″	soft weathered coal
9″	brown shale and coal
14″	soft black shale and silicified wood
14″	soft friable dirty coal
18″	dark brown shale
11″	soft weathered coal
4″	brown bentonite
27″	coal and bone too high in ash to be marketed
3″	bone
80″	coal, hard and blocky

Hard sandstone floor.

Coal Analyses

Coal samples collected by the District Inspector of Mines, Mr. A. B. Hunter, were analysed by W. A. Lang, Research Council of Alberta, under the direction of E. Stansfield. The following results were obtained:

Mine No.	Moisture	Ash	Volatile Matter	Fixed Carbon	B.T.U.	Fuel Ratio
1432	25.3	6.3	30.1	38.3	8,570	1.25
443	26.4	6.0	30.2	37.4	8,470	1.25
1416	25.8	5.6	29.8	38.8	8,690	1.30
497	25.3	7.1	28.5	39.1	8,610	1.35
1314	26.1	5.5	29.8	38.6	8,710	1.30
1370	27.9	5.4	28.7	38.0	8,340	1.35
486	29.7	8.9	27.5	33.9	7,520	1.25
1401	33.7	6.5	26.7	33.1	7,410	1.25
1236	28.8	8.3	27.7	35.2	7,700	1.25
1398	29.9	6.1	28.8	35.2	7,810	1.20
1231	26.9	7.3	28.7	37.1	8,090	1.30

WATER RESOURCES

In the Sounding Creek sheet the surface water is not suitable for domestic purposes. Bullpound, Berry, Blood Indian, Alkali and smaller tributary creeks draining southward into Red Deer river, and Sounding Creek draining northward in the northeast corner of the map are all slow flowing and in places stagnant. There is considerable alkali in the surface deposits so that the flowing water is in places strongly alkaline. Most of the lakes in this area are small and without outlet drainage so that most of these lakes contain stagnant water. Many of the lakes shown on the map have dried up since the date the map was prepared. Dowling lake, which is the largest, has become obliterated by evaporation.

The underground water supply varies in different sections in this area. The present survey has indicated that there are certain horizons in which a supply of underground water may be expected. Many wells of excellent water were visited, but there are also many wells where the water is highly mineralized and unpleasant as to taste and odor, while others are quite unsuited for domestic purposes.

In this report some of the facts will be given as to the underground water.

There is a good water supply at shallow depths on and adjacent to the Hand hills in the Paskapoo formation. The sand hills and other glacial morainal deposits have been proven to contain water at many points, especially at higher levels and away from depressions or old lake beds where there has been an accumulation of alkalies.

There are several beds of sandstone in the Edmonton formation in which water can be expected. It would appear that the sandstones between the No. 1 coal seam and the bottom of the formation contain water of good quality. Sometimes water from this formation has a slight taste of soda or iron, but in the main the water can be used, especially if it does not stand in the well as it then tends to become tainted in taste.

The writer did not come across any good water in wells drilled into the Bearpaw formation. As stated above this formation consists chiefly of shales of marine deposition in which the alkali content is high. It is a fact that good water cannot be expected to be encountered in this formation. This Bearpaw formation occurs at the surface over a large area in the Sounding Creek sheet, and underlies most of ranges 5 to 12, and along the flats adjacent to Bullpound and Berry creeks. In this belt good water is rare unless it is obtained from the overlying glacial sands, and it is not advisable to drill or dig wells into this shale.

In the Bearpaw shale area the only chance of getting a suitable water supply is to drill through this formation into the underlying Belly River formation. The depth that would have to be drilled to penetrate the Bearpaw would vary with the location as it has a maximum thickness of 500 to 700 feet near the Edmonton contact, and thins out to the east where it disappears when the Belly River strata reach the surface.

The Belly River formation contains much sandstone suitable as a container of water and is of continental or fresh water deposition.

At Oyen a water supply is obtained at a depth of 300 feet where the Belly River is encountered below the Bearpaw. If a well is drilled into the Belly River it is important that care should be taken with the casing so as to prevent impure water from the surface or from the Bearpaw entering the well and contaminating any water of good quality that may be encountered in the Belly River.

Water of good quality is known to occur at different horizons in the Belly River formation adjacent to the Alberta-Saskatchewan boundary and at many other places in Alberta. Observations were made by the writer on a series of strong flowing springs which occur along an escarpment about 3 miles east of Alsask in Saskatchewan. The water from these flowing springs is of excellent quality for domestic purposes. This water is pumped to Alsask by the Canadian

National Railway. This water is coming from sandstone beds in the upper part of the Belly River formation which here come to the surface. It is believed that this water is coming from about the same horizon in the Belly River as is encountered in the wells at Oyen at a depth of 300 feet.

As much of the underground water is of local origin care should be taken to retain rather than drain as much of the local rainfall as is possible. This important fact is not fully appreciated, yet it is reasonable to assume, since much of the underground water supply is of local origin, that by retaining the precipitation there will be a better chance for more of that water to penetrate the underlying formations suitable as water-bearing beds than there will be if the surface is drained or if the spring runoff is not retained. It is believed that in a district such as the one discussed, where the rainfall is light, that the problem of retarding the runoff is worthy of study and of close consideration.

SANDSTONE QUARRY AT COCHRANE

In 1931 the sandstone deposits in the Cochrane district were examined in order to determine the suitability of these sandstones for building purposes. A report on these deposits by the writer is contained in the Twelfth Annual Report of the Research Council of Alberta, Report No. 27, page 20, 1932. In this report the Oliver Quarry was described as containing sandstone of a quality suitable for building purposes. A topographical map of the vicinity of this quarry was prepared for Report No. 27.

In 1935 sandstone from the Oliver Quarry was utilized in the construction of Royal Canadian Mounted Police barracks in Calgary.

This quarry, owned and operated by William Oliver, is situated 3.8 miles by motor road from the Canadian Pacific Railway at Cochrane, on the north bank of Bighill creek, in legal subdivision 9, section 18, township 26, range 4, W. 5th M. The face of the quarry when examined in July exposed the following section:

3′ 0″	soil
5′ 0″	shaly sandstone badly fractured
1′ 6″	shale
3′ 3″	massive grey sandstone with a few shatter joints
3′10″	massive grey sandstone (quarried for R.C.M.P. barracks, Calgary).

The sandstone beds are approximately horizontal in which the master joints are used as the face and strike N20°W and dip 72°S.W. The minor joints are approximately vertical and strike S70°W into the hill. (Photograph 6.)

The quarry is within 150 feet of the roadway. The blocks of sandstone are broken from the face by channelling and transported by truck to the plant in Cochrane, where the blocks are sawn and planed to the dimensions required.

The sandstone is of uniform grey color and is free from minor bedding planes. Mr. Oliver informed the writer that he does not cut the stone to be used at a "tilt" because this stone gives the most satisfactory service when placed flat with bedding planes. This sandstone is of Lower Tertiary age (Paskapoo formation), and is not as highly indurated as an older stone. It has been proven that this is a good building stone, durable and easily worked and is an important asset to Alberta. Chemical analyses and physical tests have been previously published in Report No. 27.

Bighill Creek Tufa Deposits

Tufa deposits occur along the bottom of a small draw entering Bighill creek north of Cochrane, Alberta, in sec. 29, township 26, range 3, west 5th meridian, The deposits extend along the valley floor for about 800 feet and the upper end of the deposit is about 200 feet higher than the lower end. Tufa is a spring deposit and consists of calcium carbonate. The tufa has been deposited from lime-rich water which issued and is still seeping from the escarpment on the west side of the valley. This escarpment is formed in the Paskapoo, and the lime content is high in some of the beds in this formation. The tufa has built up waterfalls to the number of a score or more. The highest fall is about 16 feet. Much colored algae occurs with the tufa and the appearance is most attractive. Vivid blue, green, brown, red and yellow algae predominate. Blocks of this tufa have been used for decorative walls and rock gardens. It was proposed to utilize this tufa as a travertine, but there is little or no solid travertine in the whole deposit and the tufa is characteristically porous and soft. It is reported to have been used as terrazzo with satisfactory results.

This locality is of greater importance to Alberta as an attractive and picturesque spot for the visitor. The writer considers that this short valley containing the tufa deposits is one of the most beautiful spots in Alberta east of the Rocky Mountains, and recommends that it should be preserved as a park reserve for the pleasure of visitors. At present much destruction is done to the beautiful waterfalls by visitors and by the trampling of cattle. The general appearance of some of the waterfalls in this natural park is shown in photograph 7.

Radnor Tufa Deposit

Information was requested as to the character, extent and suitability of a "travertine" deposit which was proposed to be used in the Parks Administration building in Banff. The writer examined this deposit, which occurs on the east side of Bow river about one mile below the Calgary Power Company Ghost dam and across the Bow from Radnor station on the Canadian Pacific Railway 33 miles west of Calgary.

This deposit is chiefly tufa and not travertine. The tufa has been deposited on the side of Bow valley from water issuing at four points along a level 77 feet above the Bow river and along the contact of the glacial deposits and the underlying Alberta Shale formation of Upper Cretaceous age. The deposits extend horizontally for about 150 feet at the top and for 205 feet at the river level.

The tufa has been deposited in layers as the water flowed down the valley side so the tufa occurs distinctly bedded as shown in photograph 8. The greatest thickness of the tufa observed is less than 10 feet. Along the lower levels, near the edge of the Bow, there is a tufa conglomerate-breccia between the pure tufa and the underlying shale and gravel talus. There are some thin bands of compact tufa approaching travertine, but these bands are quite limited in quantity and are lensy. The whole deposit is soft lime carbonate and the porosity varies from about 5% to over 50% by volume.

This is tufa spring deposit, and several other similar deposits have been examined in this district along the Bow and the Ghost rivers. Similar deposits are quite common throughout Alberta.

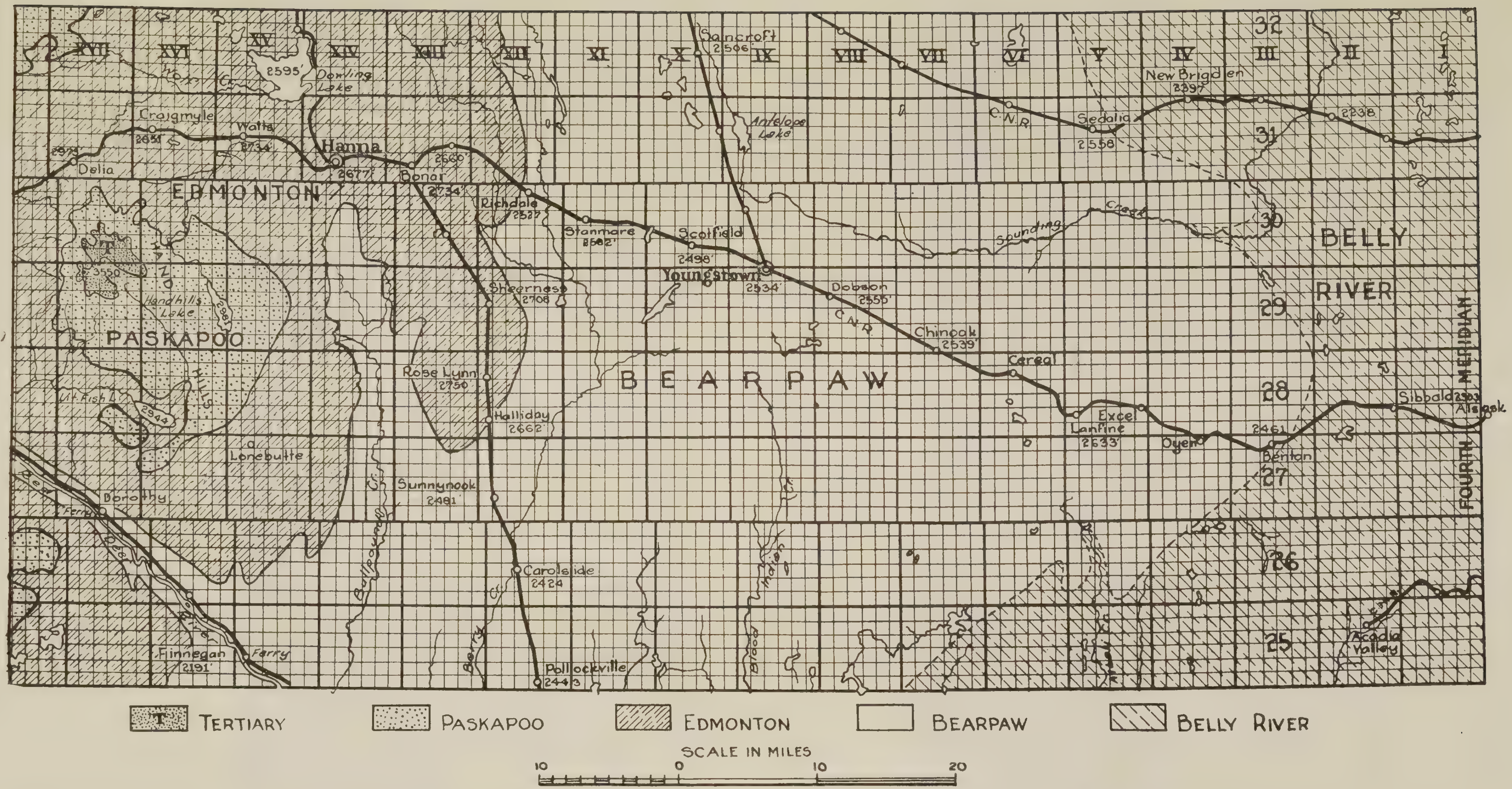


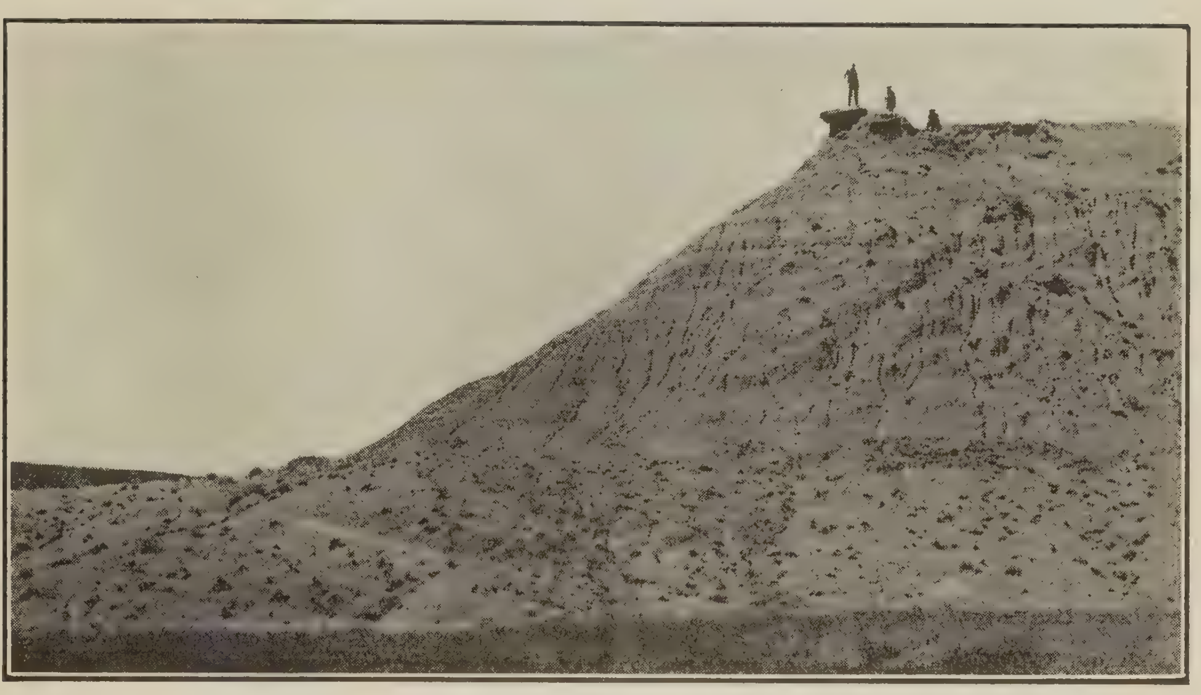
Plate 1.—Geological map of the Sounding Creek sheet and the Sheerness Coal area showing distribution of Upper Cretaceous and Lower Tertiary formations.

1.—No. 1 Pit, Leavell Coal Co., Ltd., Sheerness, Alta. The water is the result of a recent cloudburst.

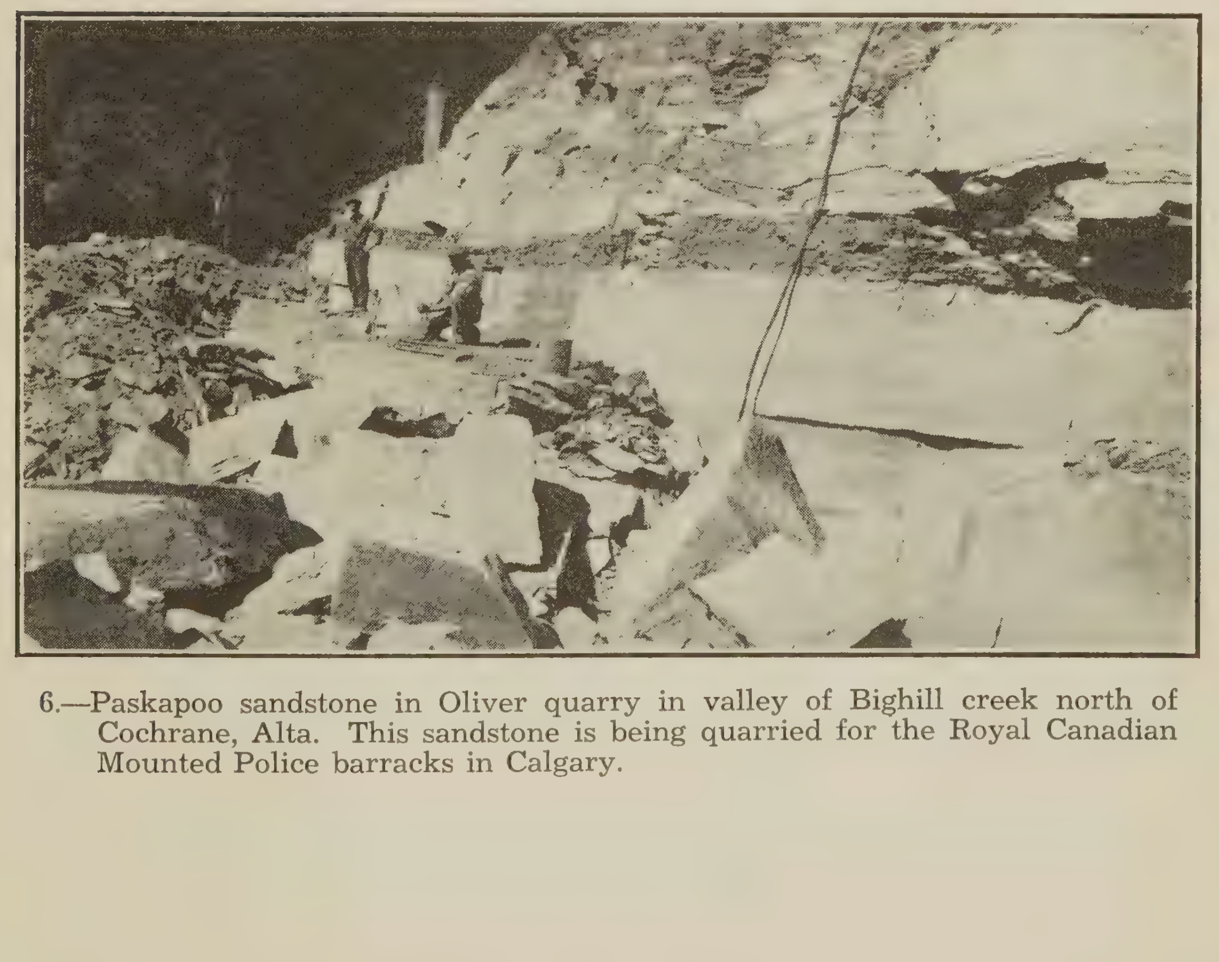
2.—No. 2 Pit, Leavell Coal Co., Ltd., Sheerness, Alta., showing the working face and the depth of overburden removed.

3.—Strip pit mining, Chinook Coal Co., Ltd., Sheerness, Alta., showing the depth of overburden removed.

4.—Working face on No. 1 coal seam, Chinook Coal Co., Ltd., Sheerness, Alta., showing blocky character of coal.

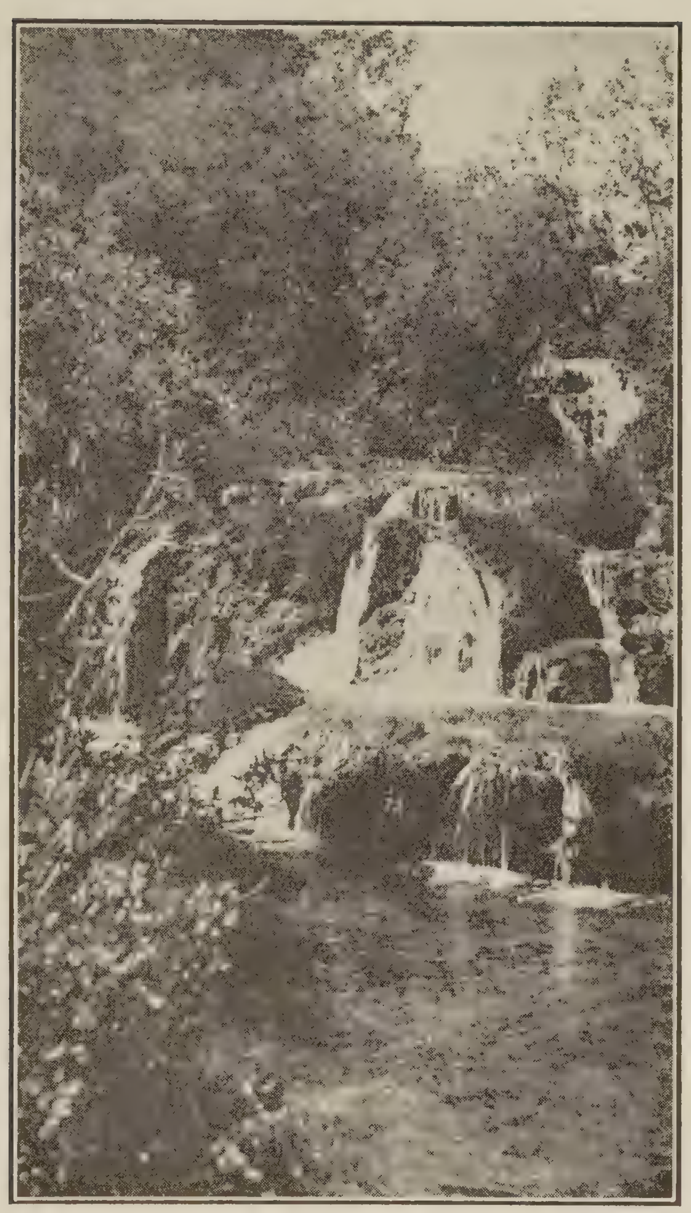


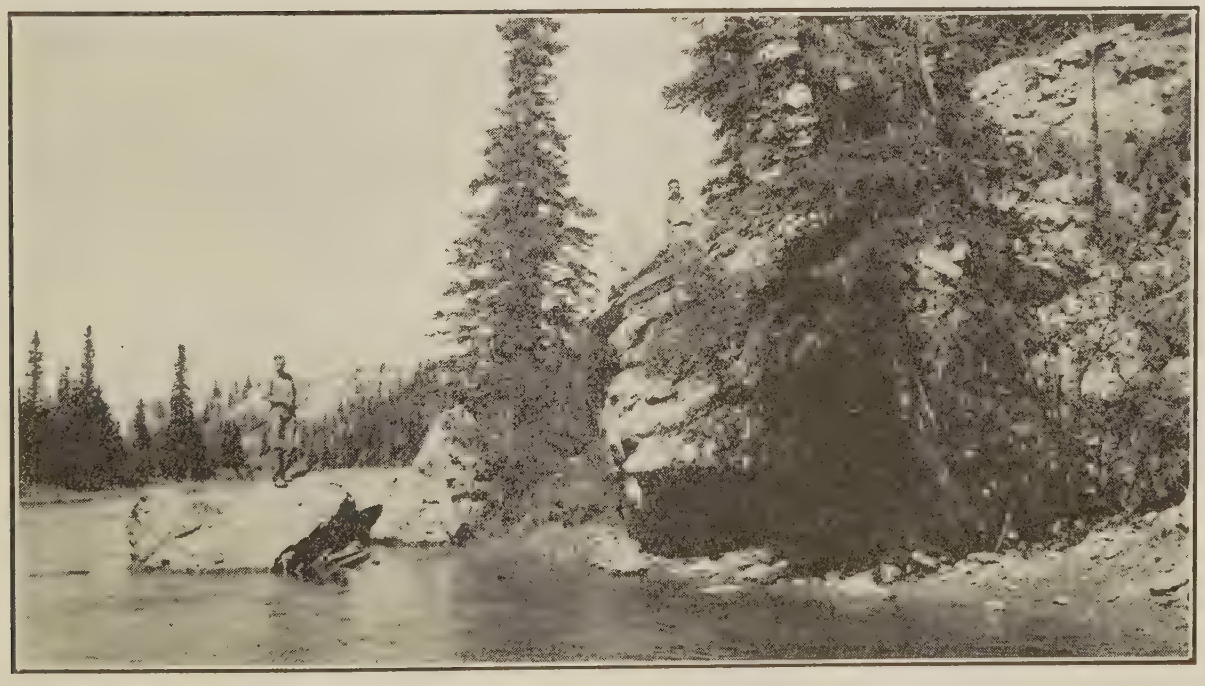
5.—Bearpaw shales capped by basal sandstone bed in Edmonton formation. The thin white bands are bentonite. Taken in sec. 3, tp. 27, rg. 17, east of Dorothy ferry across Red Deer river.



6.—Paskapoo sandstone in Oliver quarry in valley of Bighill creek north of Cochrane, Alta. This sandstone is being quarried for the Royal Canadian Mounted Police barracks in Calgary.

7. — Beautiful waterfalls formed on tufa deposits with many colored algae in a small valley tributary to Bighill creek north of Cochrane, Alta.





8.—Tufa spring deposit on north side of Bow river opposite Radnor station on Canadian Pacific Railway, one mile east of Calgary Power Company dam at Ghost river and 10 miles west of Cochrane.

ROAD MATERIALS DIVISION

BY K. A. CLARK

HIGHWAY SUBGRADE STUDIES

A start was made in 1934 on the study of highway subgrade and related problems, this work being continued in a small way during 1935. One month was spent in the field and the samples of soil and gravel then collected were examined later in the laboratory. The investigation was made possible by a grant of money from the Carnegie Research Fund under the administration of the University of Alberta.

A soil profile was made along a half mile stretch, about three and a half miles beyond St. Albert, on the highway running north from Edmonton through Morinville. This included two sections where the subgrade softened badly in the spring and remained unstable till early summer. The difficulty apparently arises from the presence in the subgrade of soil layers which are subject to frost heaving and to a high water table. These conditions are general along the highway, and caused so much trouble that the highway had to be closed against heavy traffic for several weeks. The data obtained by the investigation provide a basis for consideration of measures to be taken to stabilize the subgrade.

STABILIZED GRAVEL SURFACE

The gravel deposit at Hinton and soil conditions along the highway between Hinton and the boundary of Jasper Park were examined to determine whether materials were at hand for constructing a stabilized gravel surface. This type of gravel construction is coming to the fore rapidly throughout the continent. It consists of combining gravel and soil of suitable properties to obtain an aggregate with a distribution of sizes of pebbles and smaller particles falling within known optimum limits, and having a soil mortar of proper cementing qualities for bonding the aggregate firmly on the road surface. A deliquescent salt, generally calcium chloride, is added to the aggregate to draw moisture from the atmosphere and keep the soil mortar active as a cementing agent.

A TRAFFIC COUNT ON HIGHWAY No. 1
South of Edmonton

After completing the field work on the two projects mentioned, a small amount of the grant remained unexpended. It was used in making a traffic count at a point on the Edmonton-Calgary highway, one mile north of Millet. The count was maintained for sixteen to twenty-four hours per day during five days. The purpose was to get information about the variation in traffic flow on Alberta highways throughout the hours of the day, and from day to day throughout the week. These variations and that for the seasons of the year must be established before traffic counts for a limited number of hours can be expanded with any accuracy to "vehicles per day," the common unit for stating traffic volume. Interesting data were obtained at the point of observation regarding truck traffic and passenger cars from outside the province.

The way in which the traffic on Alberta highways varies throughout the hours of the day, the days of the week and the months of the year, must be established before traffic counts at various points along the highways can be interpreted and expanded to some common basis of comparison. Volume of traffic is generally stated as the number of vehicles per 24-hour day for the average day of the year, or for some such significant period. It is impractical to actually count vehicles passing a point twenty-four hours a day throughout such a period. Traffic surveys are made by counting at a station for ten hours or so, moving on to the next station for another count and so on for a chain of stations, coming back to the stations according to a planned schedule. If the laws of traffic flow are known, these ten-hour counts can be corrected to give the flow for the twenty-four hours of the particular day, for the average day of the week, and finally for the average day of the year.

An opportunity occurred for making a traffic count at a point near Edmonton for a few days during the month of July, 1935. The point for the observations was chosen on Highway No. 1, one mile north of Millet and about twenty-five miles south of Edmonton. The vehicles were counted from 3 p.m. to 9 p.m. Thursday, July 25th, from 6 a.m. to 10 p.m. Friday the 26th, from 6 a.m. to 10 p.m. Saturday the 27th, from 6 a.m. to an hour after midnight Sunday the 28th, from 6 a.m. to an hour after midnight Monday the 29th, and for the full twenty-four hours starting at 6 a.m. on Tuesday the 30th. The weather was fair, except on Sunday when it rained heavily from 10 a.m. to 2 p.m., and was showery for the rest of the day and evening.

In this count trucks were divided into heavy, medium and light. Commercial freighting trucks, oil tank-trucks and other big trucks were classed as heavy; the common farm truck of about 2½ tons capacity were classed as medium; and small one-half and one ton trucks were classed as light. Busses were counted separately. Passenger cars were divided into Alberta, British Columbia, Saskatchewan, other Canadian and United States cars.

A summary of the results of the count is presented in the following tables. Since counts for some of the early morning hours were only made for one day, a guess based on the one count for these hours has been made for the other early mornings.

TABLE I.—Hourly Variation in Passenger Car Traffic
Number of Cars

Day	6 a.m. to noon	Noon to 6 p.m.	6 p.m. to Midnight	Midnight to 6 a.m.	24 hours
Monday	127	240	167	18	597
Tuesday	129	203	138	18	488
Friday	128	221	148	18	515
Saturday	116	303	185	32	636
Sunday	178	300	321	28	827

TABLE II.—Hourly Variation in Passenger Car Traffic
Percent of 24-hour Day

Day	6 a.m. to noon	Noon to 6 p.m.	6 p.m. to Midnight	Midnight to 6 a.m.	24 hours
Week days	28	41	28	3	100
Saturday	18	48	29	5	100
Sunday	22	36	39	3	100

TABLE III.—Daily Variation in Passenger Car Traffic
Average Day of Week=100%

Day	Number of cars	Index percent
Monday	597	103
Tuesday	488	83
Wednesday	500	86
Thursday	500	86
Friday	515	89
Saturday	636	110
Sunday	827	143
Average Day	580	100

TABLE IV.—Hourly Variation in Truck and Bus Traffic
Number of Trucks and Busses

Day	6 a.m. to noon	Noon to 6 p.m.	6 p.m. to Midnight	Midnight to 6 a.m.	24 hours
Monday	41	37	29	11	118
Tuesday	60	51	47	14	172
Friday	46	44	33	10	133
Saturday	24	41	23	8	96
Sunday	14	22	21	5	62

TABLE V.—Hourly Variation in Truck and Bus Traffic
Percent of 24-hour Day

Day	6 a.m. to noon	Noon to 6 p.m.	6 p.m. to Midnight	Midnight to 6 a.m.	24 hours
Week days	35	31	26	8	100
Saturday	25	43	24	8	100
Sunday	23	35	34	8	100

TABLE VI.—Daily Variation in Truck and Bus Traffic
Average Day of Week=100%

Day	Number of Trucks and Busses	Index percent
Monday	118	100
Tuesday	172	145
Wednesday	125	110
Thursday	125	110
Friday	133	112
Saturday	96	81
Sunday	62	52
Average day	119	100

The traffic count, being confined to the days of one particular week, gave no information about the variation in traffic flow from month to month. However, a good approximation for the monthly variation can be made from published data on the monthly consumption of gasoline. Table VII is based on the gasoline consumption in Alberta during 1933.

TABLE VII.—Monthly Variation in Gasoline Consumption in Alberta

Month	Gasoline Sales Thousands of Gallons	Index percent of Average month
January	1,887	56
February	1,650	49
March	2,400	72
April	2,528	75
May	3,918	117
June	4,216	125
July	4,487	133
August	4,970	148
September	4,909	146
October	4,555	136
November	2,861	85
December	1,919	57

TABLE VIII.—Monthly Variation in Truck and Passenger Car Traffic

Month	Trucks and Busses per day	Passenger Cars per day	Total Traffic per day
January	50	235	285
February	44	205	249
March	65	300	365
April	67	315	382
May	105	490	595
June	112	525	637
July	119	580	699
August	133	620	753
September	131	615	746
October	122	570	692
November	76	360	436
December	51	240	291
Average month	90	435	525

Traffic was counted on Thursday from 3 p.m. to 9 p.m. The observed traffic was 188 passenger cars and 35 trucks. This period of time does not correspond to those given in Tables II and V. It was determined from the original data that from 3 p.m. to 9 p.m. on a week day there is 42% of the passenger cars traffic and 33% of the truck traffic. Consequently the total traffic for the 24 hours from 6 a.m. Thursday may be calculated as 450 cars and 106 trucks, and for an average day of the week as 525 cars and 97 trucks. The figures for the traffic for the average day of the week given in Tables III and VI are 580 cars and 119 trucks.

The proportion of heavy, medium and light truck traffic during the period of the count was:

Heavy trucks and Busses	36% of truck traffic
Medium trucks	43% " "
Light trucks	21% " "

The proportion of passenger car traffic coming from outside the province was:

British Columbia cars	1.4%
Saskatchewan cars	2.4%
Other Canadian cars	1.6%
United States cars	1.6%
Total	7.0%

About two percent of the passenger cars had trailers. These were about evenly divided between trailers for camping purposes and farm trailers for hauling stock and supplies. One horse-drawn vehicle passed the station during the count.

Admittedly the basis upon which this traffic analysis is made is meagre. However, the results and indications are of some value and interest.

NATURAL GAS RESEARCH

By E. H. BOOMER, *Associate Professor of Chemistry*

The following comprises a brief summary of the work on natural gas during the past year. Detailed accounts will be presented later as reports to be published by the National Research Council of Canada and as theses for deposition in the University Library.

Although no financial assistance was provided by the Research Council of Alberta, grants from the National Research Council of Canada and from the Carnegie Corporation Research Grants administered by the University were procured in sufficient amount to carry on the work. C. A. Johnson, B.Sc., continued the research on gas solubilities in liquid hydrocarbons under the National Research Council grant. V. Thomas, B.Sc., continued the research on the direct oxidation of natural gas, holding a scholarship from the Carnegie Corporation Research Grant, and assisted by an apparatus grant from the National Research Council.

An investigation was opened which deals with the polymerization and alkylation reactions possible with olefine containing gases produced by cracking of natural gas. This research is strictly a continuation along one line of previous work here on natural gas. J. H. Shipley, B.Sc., is carrying on this work, holding a scholarship from the Carnegie Corporation Research Grant. These assistants are members of the graduate school of the University and proceed to the degree of M.Sc. in May, 1936.

Grateful acknowledgment is made to the National Research Council of Canada and the Carnegie Corporation Research Grant Committee for grants-in-aid, and to the University of Alberta for laboratory space and facilities provided.

SOLUBILITIES IN HYDROCARBON SYSTEMS

This work, having for its primary object the elucidation of conditions in the producing sands of the Turner Valley, has progressed in an excellent manner during the past year. Two component systems using as gas, methane, and as liquid the following, N-heptane, benzene, toluene, and cyclo-hexane, have been examined at pressures up to 5,400 lbs. per sq. in. and at temperatures from 25°C to 115°C. Densities and compositions of both liquid and gas phases have been determined. Work is in progress at present on pentane, hexane and methyl-cyclohexane. The compounds cited are all common constituents of Turner Valley products. The results have been of great interest in both theory and practice. There appears to be little doubt of the existence of a liquid phase in at least some of the Turner Valley producing areas.

Circumstances permitting, an investigation of complex mixtures such as occur in the Valley will be carried on in the coming summer, and an endeavour made to give an unequivocal picture of conditions in the oil sands. It is hoped also to show that a knowledge of simple two component mixtures will permit the prediction of the behaviour of more complex mixtures.

OXIDATION OF NATURAL GAS

This work, an investigation into the possible production of useful compounds, principally methyl alcohol, from natural gas by direct oxidation under pressure, has proceeded with rapidity. An apparatus and technique have been worked out that give excellent performance and a great deal of data have been collected. Various air and gas mixtures have been allowed to react in the presence of a copper catalyst at pressures from 2,000 to 3,400 lbs. per sq. in., at temperatures from 375°C to over 500°C and at various rates of flow. Each variable has been investigated individually in its influence on yields. Generally, it may be said that for any one mixture, there is an optimum temperature for maximum yield. With mixtures of low oxygen content this temperature is high and as the oxygen concentration is increased, the optimum temperature decreases. Also in general, the yield decreases, even at optimum temperatures, as the oxygen concentration is increased. The effect of pressure is somewhat like that of temperature; maximum yields occur at an intermediate pressure of about 2,800 lbs. per sq. in. and are less at lower or higher pressures. Rates of flow have little or no effect on yields over a wide range of values. Only at extremely low or high rates of flow do the yields fall off.

Conversions of gas burnt to methyl alcohol of 74% are readily obtained at low oxygen concentrations. If the formic acid and formaldehyde produced are also included, the total yield reaches 79%. Because of the low oxygen concentration used, a circulatory process is indicated in any commercial application.

Preliminary experiments have been carried out on the effect of the catalyst. A catalyst is essential, and plays an important role in altering the yields, iron or an iron-nickel-chromium alloy being inferior to copper. Experiments are still in progress seeking catalysts superior to copper.

POLYMERIZATION

This work was suggested some years ago and a series of experiments at atmospheric pressure carried out. The work is based upon previous observations that natural gas constituents could be decomposed by heat with the production of gaseous olefines. It is well known that the olefines will polymerize, particularly under the influence of pressure and heat to yield liquids having the characteristics of high grade motor fuels. Further, it is possible to cause the addition of olefines to liquid hydrocarbons (alkylation) with an improvement in their quality as motor fuel. Turner Valley naphthas are notoriously of poor quality because of low anti-knock rating as motor fuel. Introduction of olefines by alkylation or blending with the product of olefine polymerization offers a simple and promising method of improving the product of Turner Valley.

In the present work propane is decomposed by heat at atmospheric pressure to yield a gas containing 40% olefines, 15% hydrogen and simpler paraffins. Propane is a constituent of natural gas and, together with large amounts of similar gases, is readily available in Turner Valley. The olefine containing gas is compressed and heated, alone or in the presence of liquid hydrocarbons. The olefines polymerize rapidly to form liquids, are stabilized to some extent by reduction due to hydrogen and probably combine with part of the paraffin gases. In the presence of liquid paraffins and other compounds, the alkylation reaction occurs with direct union of the olefine and liquid.

Considerable preliminary work of a promising nature has been carried out with best results in the polymerization process. Apparatus and methods have been developed to a satisfactory degree and this work should progress rapidly in future.

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